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# Methodology for Assessing Environmental Implications and Technologies Nonferrous Metals Industries

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The objectives of this task were to: 1) consider alternative methodologies for information collection, analysis, and presentation; 2) design a system for maintaining current awareness of the environmental implications of technology in the non-ferrous metals industry; and, 3) estimate the costs required to implement the detailed plans developed. Although this task was specific to the non-ferrous metals industries, the methodologies developed could be applied to maintain awareness in virtually any field.

Existing information centers and systems were studied and pilot sampling operations were conducted to determine which elements were best suited to serve the considered awareness task. Investigation and selection of the preferred elements for the task were accomplished under the guidance of the project officer, with input-output options of the information system being developed to match specific requirements.

The input-output elements recommended to serve this awareness function include primarily the reliance upon a preferred list of periodicals (augmented by symposia, reports, and communications with specialists), selection and analysis of information deemed significant by a senior technologist; and publication of an Awareness Bulletin on a timely basis.

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# FOREWORD

When energy and material resources are extracted, processed, converted, and used, the related pollutional impacts on our environment and even on our health often require that new and increasingly more efficient pollution control methods be used. The Industrial Environmental Research Laboratory-Cincinnati (IERL-Ci) assists in developing and demonstrating new and improved methodologies that will meet these needs both efficiently and economically.

The subject of this report is the development of a methodology for maintaining awareness of the environmental implications of nonferrous metals technology. Although the direct results have only limited range of utilization, the structure of the proposed program and options can be readily applied to almost any field where there is a necessity to maintain a high level of technical awareness of new development with limited in-house staff. Therefore, anyone within EPA, other Governmental Agency, or Research Institutes can adapt the products of this study to meet their own needs. Further information for this study may be obtained by contacting the Industrial Pollution Control Division, Metals and Inorganic Chemicals Branch.

David G. Stephan
Director
Industrial Environmental
Research Laboratory
Cincinnati

# ABSTRACT

This research program was initiated with the objectives of defining and considering alternative philosophies and methodoligies for information collection, analysis, and presentation, and as a result of such investigation, to design a system for maintaining current awareness of the environmental implications deriving from the technology of the nonferrous metals industry. A further objective was to estimate the level of effort required to implement the detailed plans developed.

The approach used in satisfying the objectives of this study involved several steps. Methodologies and philosophies of several metal information centers and systems serving functions similar to the desired function were examined. Elements of such systems were found to include operations concerning information identification, collection, indexing, storage, retrieval, selection, analysis, and preparation of outputs releasable to users in several forms. Each of these functions was considered in light of the specific EPA need.

Detailed components of system elements, such as periodical literature, abstract publications, company annual reports, and research-in-progress data bases, were studied in sampling operations to form a basis for assessing the value of selected information sources. The results of these investigations (for example, the discovery that about 60 periodical publications permit the coverage of the bulk of reportable information on a wide range and scope of nonferrous metals and processes) set the stage for designing an information system to serve the awareness function.

Interaction between the EPA Task Officer and project personnel, specifically guidance regarding the preferred options to be developed in detail (selected from an input-output option matrix with associated relative rates-of-effort information), allowed for the development of a recommended system regarding the considered task. The recommended input-output elements include primary reliance upon a preferred list of periodicals (about 60) as an information source, selection and analysis by a senior technologist of information deemed significant, and preparation of output in the form of an Awareness Bulletin.

Important augmenting and auxiliary operations include (1) utilization of other information sources that might be available from symposia, company annual reports, abstract services, and industry specialists, and (2)

establishment of interactive communications between "Bulletin" generators and users on a timely basis so that output remains current but perhaps evolutionary in form and content to best serve EPA user awareness needs.

The details of the recommended format for the Awareness Bulletin as well as for an initial taxonomy suggested as an aid in the continuous filing of issued "Bulletins" are also described. Rates of effort required to conduct each system component are estimated, along with the total cost of the exemplary operation, designed to achieve the EPA awareness function.

The study of methodologies applicable to developing an "awareness system" was conducted under Contract 68-02-1323, Task No. 54, in support of USEPA Milestone 2.1 07A-01. The investigative effort began in mid-March, 1976, and work was completed as of June 4, 1976.

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# SECTION 1

## INTRODUCTION

The U.S. Environmental Protection Agency (USEPA) has expressed a need for a formal mechanism to maintain current awareness of the environmental implications of technology in the nonferrous metals industry. This study was conducted in response to that need in support of Milestone 2.1 07A-01. Its objectives were as follows:

(1) Define and consider alternative philosophies and methodologies for prompt information gathering, analysis, and presentation.

(2) Select those options that appear to meet the expressed EPA needs most effectively.

(3) Develop detailed operational plans and activities for the options selected.

(4) Estimate the level of effort associated with the detailed plans.

For this study, the nonferrous metals industry is considered to comprise all facets of the production of marketable nonferrous metals, except fuels (uranium and thorium), and nonferrous metals processing within the ferroalloy industry. Included are mining, milling, and metal-producing operations as well as the production of metals from secondary resources. The technology considered is primarily that associated with the direct processes whereby the metals are won from the earth or reclaimed from scrap. However, ancillary processes, such as power generation and pollution control processes, are included in considerations, insofar as they are directly practiced by the nonferrous metals industry. For example, reports describing the characteristics of a new type of bag house that might be only incidentally applicable to the lead industry would not be within the scope of methodology definition, but a report of the actual use of this new bag house by the lead industry would.

The focus of the EPA need is on an assessment of environmental impacts. Thus, only technology descriptions, comments, etc., that are stated or could be inferred to effect an environmental impact would be considered by any of the plans recommended for implementation as a result of this study. In this context, information on emerging technology (R&D, pilot plant, and prototype operations) and the processes involved will be of obvious import. Likewise, intelligence relating to a gradual industrial shift from one process flow to another (e.g., the total abandonment of horizontal zinc retorting that became fait accompli in 1975) must be an awareness target. Continuing technology statements would be of interest only in the event that environmental considerations become better defined or understood as a result of the new data that might be contained.

A constraint in the development of the alternative models for serving the awareness function was that the considered operations should be conducted at a relatively modest rate of effort -- that is, about 1 man-year per year. This restriction placed obvious limits on coverage and functional operations to be considered. The models developed generally conformed to this constraint.

This report describes the approach used to develop the various methodological options and the recommended system along with rate-of-effort requirements designed to meet the USEPA needs.

# SECTION 2

# CONCLUSIONS

This study of the methodologies for maintaining awareness and assessing the environmental implications of nonferrous metals technology resulted in the following conclusions:

(1) The basic elements of a preferred methodology to serve the awareness requirements of USEPA regarding nonferrous metals technology and associated environmental concerns are:

- Location and input of significant information.
- Selective culling, review, and analysis of input information.
- Preparation and output of a periodic report on the information in the form of an Awareness Bulletin.

(2) Input information to satisfy the awareness requirements could rely on:

- Pertinent periodical literature for primary input (about 60 preferred periodicals could afford coverage)
- Technical conference information to augment other input (attendance and correspondence could afford coverage)
- New, confirming, or ancillary information obtained from cognizant government and industry specialists.

(3) Information selection, review, analysis, and output operations should be conducted by a senior technologist having skills and familiarity with:

- Nonferrous metallurgy and its industry
- Environmental aspects of the industry and the USEPA mission
- Information systems operations

(4) Input-output strategy and associated subject taxonomy should be developed by operator-user interaction in an evolutionary process to continually serve the USEPA information needs.

(5) Awareness Bulletin periodic output should contain information in a brief but comprehensive style with subject matter and format amenable to a continuous filing system.

(6) Information outputs in the form of in-depth topical reports and inquiry answering services commonly ancillary to information systems are not necessary to the basic function of the considered task.

(7) The desired objective could be accomplished with annual funding equivalent to somewhat less than one technical man-year of effort.

# SECTION 3

# RECOMMENDATIONS

In accord with the findings of this task, and as guided by statements of preference by the USEPA Task Officer, the following recommendations are made:

(1) USEPA should initiate a research support program designed to provide continuing awareness of technical progress within selected segments of the nonferrous metals industry, and to assess the technology relative to actual or potential environmental issues.

(2) The methodology recommended for this considered program is as follows:

(a) Input would be supplied on the primary basis of about 60 preferred domestic and foreign periodical publications. These would be screened to extract articles of potential value. A selection of most pertinent information items would be culled from these screened items. A limited and carefully selected number of translations of foreign language items is anticipated. This primary information source would be augmented by information from selected conferences (attendance at two), from personal visitations to selected government and industry specialists (8 to 12), and from pertinent report and patent literature. Information coverage would be checked by occasional library searches of abstract services.

(b) Selected information obtained from the above sources would be reviewed, analyzed for environmental implications, and summarized preparatory to the issuing of Awareness Bulletins on a bimonthly schedule. It is further recommended that the Awareness Bulletin format should include pagination classification according to a subject classification that would include metal, process, and major area of environmental implication, where these are defined. Issues of this bulletin would be concise textual, and, as warranted, data summary statements, and are currently estimated to be about 10 pages in length.

(3) The operation of the considered awareness task should be managed, and much of the work conducted, by a senior technologist having skills and familiarity with nonferrous metallurgy, its industry, the associated environmental aspects, the USEPA mission, and information systems operations.

(4) A one man-year level of effort is recommended as being adequate to perform recommended methodology. The estimate includes a 10 percent increment for costs and services (e.g., fiscal reporting requirements, telephone and letter communications with EPA, coordination and administrative effort, etc.) not directly related to the primary operation of Awareness Bulletin preparation and publication. It does not include a fee, as would be applicable to a research contract, nor does it consider possible cost sharing in the event that the activities are conducted on a grant basis.

# SECTION 4

# DISCUSSION OF INFORMATION SYSTEM MODELS

## INFORMATION SOURCES AND INPUT METHODOLOGY

A most important aspect of developing an information system is obtaining the information to be treated. In such a task for EPA, the overriding need will be to maintain current awareness of the future trends and the status of current technology relative to the impact of the nonferrous metals industry upon environmental quality. Emphasis in the procuring of information must, therefore, be upon the timeliness of information. It will not be sufficient to include information that is several months old if the EPA planning functions, resulting from the output of such a task, are to be timely and pertinent.

There are three basic sources of information and data. These are the written literature, oral communications and personal contacts, and research and development in progress. Most of the progress in technology in the maintaining of supplies and production of nonferrous metals occurs within the industry. Further, because of proprietary interests, the major reliance on information from industry must be upon the open literature. However, considerations and suggested methodologies to collect information from all three types of sources are discussed in the following paragraphs.

### Written Literature

To assess various methods in popular use for accessing information, personnel of several library and information services in operation at Battelle's Columbus Laboratories were consulted. Of particular interest were methods of culling information from trade publications and the open technical literature. The information centers surveyed were:

- Metals and Ceramics Information Center (MCIC)
- Copper Data Center
- Iron Information Center
- Cobalt Information Center.

These centers include the functions of specific information acquisition, storage, review, analysis, and topical reporting within their scopes of activity. Some of these centers have been in existence for greater than 20 years, and current methodologies have evolved over a number of years.

Library operations were also investigated. In general, the basic function of a library is to acquire, store, and retrieve publications for users. Among the services offered are interlibrary loans, literature searches, journal circulation, article reproduction, and translation. In addition to the Battelle Main Library, the following topically-oriented library functions at Battelle were reviewed:

- Economics Library
- Foreign Science Library
- ERDA Library
- Environmental Library (also known as the Environmental Information and Analysis Center)
- Battelle Energy Information Center

Subscription lists for each of these operations were available for review.

Access to written literature may be provided by two methods--manual searching and machine searching. Most technical libraries maintain link. with several of the various computer data banks that exist. (The EPA Information Center in Cincinnati is typical of major libraries that offer this service.) On-line and batch searching services of information and data banks such as COMPENDEX (Engineering Index Monthly), SSIE (Smithsonian Science Information Exchange), NTIS (National Technical Information Service), and CHEMCON (Chemical Abstracts) are routinely available. In context with the timeliness requirements of an awareness task, the major question is whether computerized data bases can be expected to fulfill the EPA need. To address this, issues of Engineering Index Monthly and Chemical Abstracts were briefly perused. In both cases, it was found that normally a 3- to 6-month lag occurs between the original article publication and its recording in the abstract journal. (The machine and published indices are about concurrent.) In some cases, the lag may be a year or more. At best, these major and comprehensive abstracting services are marginal in relation to the timeliness required by EPA. As a consequence, we consider that the literature input function for the considered task to maintain awareness of technology in nonferrous metals production should result from manual perusal of pertinent journals, transactions, proceedings, and other periodicals as near as possible to their dates of issue. In general, computer searches from abstracts might be used effectively as a postmortem exercise to check the degree of coverage completeness by the manual perusal of a preferred publication list.

Manual searches, then, are recommended as the backbone of the input function of operations to fulfill the EPA awareness need. Such searching is a commonplace activity of information centers. At Battelle, it is routinely practiced by MCIC and the Copper, Iron, and Cobalt Information Centers. The search scenario is as follows:

(1) Through experience, the center develops a list of most useful publications to be screened. Useful taxonomies are developed by center operators and users to assist document limitation.

(2) The staff member(s) spend(s) time in the library(ies) screening tables of contents of publications for articles

pertinent to the particular center's interest. For some publications, page-by-page scanning of selected documents is conducted.

(3) When an item or article of interest is found, its identification is recorded, and a log is usually kept of "hits" on a journal-by-journal basis to assist in updating preferred publication listings. When perusal of the publication is finished, the library service group makes the indicated copies and sends them to a specialist at the center for a more judicious decision as to merit and for analysis as apropos.

The above input methodology is recommended for the EPA awareness task. Trade magazines and papers, technical journals, transactions, proceedings, patent gazettes, company annual reports, and selected (short-lag) abstracting services are among the documents recommended for coverage. Detailed/ prototypical lists are presented in a later section of this report.

Literature in foreign languages, where it is covered by the centers, is managed in much the same manner. Translation, when required, may necessitate some compromise in timeliness unless the analyst is skilled in many languages. To facilitate screening of some foreign language journals, a limited table-of-contents translation service is offered by the Foreign Science Library (FSL) at Battelle on a cost basis. Selected journals are screened for the information centers by various analysts who are versed in the particular languages. Of the Soviet Union and East European foreign literature recommendations selected by the EPA project officer for potential utility, several were published in English, had English abstracts, had English tables of contents, or were available with a table of contents translation automatically produced by FSL.

The same methodology, but also including the required translation services, is recommended in dealing with foreign language inputs as for the English language literature.

## Oral Communications

Specialists at Battelle are in continual contact with various industry segments relating to nonferrous metals production as well as selected government agencies with common interests. Up-to-date information might become available from time to time from this source. Beyond this, specific periodic contacts with personnel in selected government agencies (e.g., Interior, Commerce, EPA, and possibly HEW would be federal groups with known or likely common interests) are recommended. Selected trade associations are another likely source of nonpublished information, and discreet cultivation of these sources is recommended. Such contacts should be conducted on a more or less casual basis of information--and viewpoint--exchange, but occasional personal visits (e.g., semiannually or annually) should be planned to develop and maintain information sources.

A further source of information that would add significantly to the input required for a good awareness posture would be attendance at selected major meetings, conferences, seminars, etc. Attendance at such gatherings wherein the subject matter is pertinent to developments in the nonferrous metals processing industry and/or its environmental implications would be appropriate. (We note that the AIME annual meeting proceedings provided the bulwark of the Potter/Bureau of Mines' report draft to EPA concerning the copper smelting/refining industry.) In some cases, seminar transactions are prepublished, and, in others, proceedings are not available for several months following presentation at the meeting. In any event, such seminar meetings are well supported with industrial inputs, and this would provide a major, perhaps almost exclusive basis for establishing and/or maintaining a rapport with representatives of industry. Attendance at a few carefully selected seminars/symposia, perhaps two to four per year, would be a potentially useful methodological option.

## Research in Progress

Research in progress is the forerunner of emerging technology which will set the pace for developments in the nonferrous metals producing industry. To round out the awareness of present and future activities, continuing cognizance of research in progress is recommended. In the case of industrially funded and conducted research, truly useful information will be difficult, if not impossible, to obtain from sources other than the published literature. For government-funded studies that may bear upon the topic, several sources of information are available. These range from reports of contract awards to accessible data banks containing information on contracts in force. Such information is available for many government agencies. Sources include the following:

- Smithsonian Scientific Information Exchange
- TRIS/DoT
- DOC Work Unit Summaries (ERDA 189 information)
- ERDA (maintains a computer file at Holifield National Labs)
- NASA RTOPS
- "Defense/Aerospace Contract Quarterly"
- CBD contract awards

In addition to these better known sources, the national committee on materials, COMAT, has established an inventory system to allow the subjective retrieval of all current federally-funded research and development on materials from exploration and mining through application and disposal. This system, which was piloted for FY 76, was accessed for sampling purposes in this task, as described in a later section.

Periodic retrievals of information (e.g., on a quarterly basis) from selected sources describing government-sponsored research in progress would be a useful option.

## INFORMATION INDEXING, STORAGE, AND RETRIEVAL

The need for establishing an information storage system and the most suitable methodology for information/data management is dictated by (1) the utility required in the application of the information that has been collected, (2) the quantity of information involved, and (3) the type of information involved. Several options for the management of information are:

(1) transitory collection, analysis, and dispersal

(2) temporal filing in a manual system

(3) permanent filing in a manual system

(4) temporal filing in a machine system

(5) permanent filing in a machine system.

The machine (computer) systems are effective where a large volume of information with complex indexing and a multiuse capability may be required. This is judged not to be the case in meeting the EPA needs of the moment. Machine systems were not considered for this study. (The use of existing computerized search and retrieval systems--library and data center resources--may, however, be a source of input.) Pertinent options for information management are discussed in the following paragraphs.

### Transitory Method

Transitory management implies no formal information storage at all. An information analyst would receive a document (or a group of documents) from the source(s), copy the pertinent pages or otherwise extract pertinent information (including reference), conduct an analysis (if that were a desired part of the output), formally report the information and its pertinence to the task, and return the document to the source. Further detailing or analysis of information would require reretrieval of the document from its source.

### Temporal Filing

Many filing systems include some form of rotating, or temporal, filing. In this type of filing, documents, articles, abstracts, or extracts of information are collected and may be stored subjectively in a limited filing space for a prespecified period of time, according to the needs of the information task which they will serve. At the end of the specified time, when the utility or timeliness of the document is exhausted, it is removed from the file to make room for more timely records or information. These, in turn, are filed on a time-rotating basis.

Temporal files are useful in situations where a broad range of information covering a rather large number of documents is to be maintained in a limited space, and where only a fraction of the information may be required on a permanent basis. Temporal files are usually added to, purged, and generally maintained on a chronological basis within each subject area.

As one example of their use, several technical analysts who perform periodic review functions in specified subject areas for the Metal and Ceramics Information Center maintain their personal temporal files to accumulate pertinent information. In their periodic preparation of reviews, the files are retrieved, used, and then purged when the formal review is written, as there will be no more need for this particular file. Library periodical shelves are another example of "temporal files". In this case, when they are purged, their contents are usually either bound and returned to permanent stacks or sent to a morgue.

Depending upon the option that may be selected by EPA to perform the monitoring of nonferrous metals' status of technology, temporal files might be of service. They could form the exclusive filing method, or they might be used in conjunction with a permanent system.

## Permanent Filing

If the volume of information is large or if ready access to a moderately sized information bank is desired, a permanent filing system should be established. This would probably be the case if an option calling for an interactive inquiry answering system or in-depth topical surveys were to be selected by EPA.

It is suggested that options calling for permanent files use a manual filing system. The files could comprise either standard 4- or 5-drawer document files or suitable shelving to receive copies of literature articles, reports, memoranda, etc. Each document filed would be assigned a document number, and would be filed sequentially according to that number. An indexing system could be selected that would use manually punched cards (e.g., McBee keysort cards), according to the industrial process, the metal or metals referenced, type of environmental impact, pollutant, date of reference, and other useful information. The index card also would bear all necessary reference information. Frequently, such an indexing system also contains an abstract of the information presented on the index card. However, it is not recommended that abstracts be written for indexing purposes in this case. To do so would, we believe, add substantially to the level of effort required in maintaining the file and indexing system without appreciable benefit to EPA. The inclusion of abstracts might be cost-effective only in the event that a duplicate file of index cards were to be maintained for searching, for example, at IERL in Cincinnati.

With this type of indexing system, file searching is done by serially inserting spindles in the appropriate holes in the index cards. Those that are punched according to the serial code fall out and are retrieved. This is readily done manually for small index holdings, or by machine where several drawers of index cards are to be searched. Manual operations would be appropriate, at least to start, for any option EPA might select that would require an index file. Presuming that EPA wishes to continue the analysis task for several years, drawers for index cards should be separated by years.

## INFORMATION ANALYSIS

A key factor in a successful and viable information analysis system is the experience and background of the analyst. An analyst must rapidly absorb a large amount of data, sort and select materials that are relevant and prepare an output designed to match the needs for which the analysis was conducted.

The primary objective of the awareness task will be to provide an output describing and/or analyzing the technologies in the nonferrous metals industry relative to their environmental implications.

The attributes that will be required by the information analysts to perform the desired awareness task include a background in (1) the nonferrous metals industry and (2) the USEPA mission and the specific objectives of IERL's Metals and Inorganics Branch, Industrial Pollution Control Division.

In the information selection function, independent of the output required, the specialist must establish a classification scheme based upon both the specific characteristics of the nonferrous metals industry and the detailed requirements of USEPA, IERL in this area. In general, taxonomies evolve as a function of experience, becoming more refined in response to feedback from both the information sources and the users.

Selection of pertinent information would be based upon topics mutually agreed upon between the researchers in the awareness task group and the USEPA task officer. As the program progresses, interaction between the users of the current awareness "newsletters", or other output, would provide feedback which would be a factor in the modification of taxonomy and analysis strategy.

Generally, a study and analysis function involves fragmenting a specific topic into meaningful segments to which the information analyst can match (if possible) available new data. The output of this process depends upon the type of current information that impinged upon the specialist and his ability to compose a meaningful response. The ability of the researcher to segment topics, manipulate the old and new information into the most meaningful arrangements--to synthesize an output from this process--is the essence of analysis.

In the following sections, the techniques used in the selection function and study and analysis functions will be described for three levels of output ("newsletter", summary or synopsis reports, and in-depth analysis reports such as a state-of-the-art review).

As will be discussed, the awareness "newsletter" output involves a minimal amount of study and/or analysis of the information. Its usefulness depends upon the analyst's skill in culling the salient information from a variety of sources and then briefly describing not only the nonferrous industry activity(ies) but also the potential for impact on the environment.

Consider, for example, the broad topic, hydrometallurgy, as applied to *in situ* extraction of copper-bearing material. The open literature in this area indicates not only that laboratory studies are yielding promising results but also government and industry field and pilot studies are ongoing. This background knowledge and a newly available article on this topic would allow the analyst to write a short description of (1) the process and results to date and (2) potential impact on the environment. By itself, the article might not permit an analysis in the breadth desired. The "newsletter" topic might draw upon three or four sources of information in one month, none the next month, etc.

Over a period of time, this topic might be judged to be of sufficient importance to warrant a semiannual synopsis, possibly a special bulletin. For this case, the analyst would perform a more rigorous and detailed analysis of the literature (and other sources), factoring in judgment where conflicting data are present, and assessing environmental impacts based upon more stringent criteria than would be possible for monthly "newsletter" items.

The overview provided by this level of analysis could be quite valuable to the USEPA in that it could focus attention on a technology that is rapidly evolving and track such evolution over a finite time period.

The ultimate level-of-effort in information analysis is characterized as an in-depth study of a selected topic. This level of effort would require development of a specific set of objectives to be met by the researcher. Once the objectives have been established, the information required, the extent of analysis, and additional information sources or specialists that must be contacted would be apparent. In general, the analyst would draw upon experts to provide specific inputs (such as econometrics or pollution control or regional planning). These additional inputs, as well as the output of the information analyst, would be reported in a formal document whose format would be designed specifically to meet the current awareness needs of USEPA.

In summary, the analysis of information is dependent upon the cognitive skills of the researchers involved. The taxonomy developed in conjunction with the USEPA task officer will provide the bases for selection of pertinent data. Different levels of study and analysis for developing different kinds of output ("newsletters", synopsis, and in-depth analysis) and correspondingly different levels of effort would be required.

## OUTPUT OPTIONS

The output element is dependent upon and, in some cases, limited by selection of complexity and scope of the other elements. The output options considered for the EPA nonferrous metals information need range from a simple to a sophisticated form and, in each case, are consistent with the various complexities of the input and storage elements being considered. We suggest four basic output forms as options, and, of course, combinations of these forms could be selected if deemed necessary to fulfill the EPA requirement. The basic output options are as follows:

(1) Selected information is copied then presented in a cut-and-paste format without analysis or comment.

(2) Selected information is extracted and briefly analyzed regarding environmental implications, then presented in a periodically issued newsletter.

(3) Selected topical information is collected and an in-depth analysis regarding environmental implications is presented in a formal report.

(4) Selected information is retrieved and disseminated with or without brief analysis and comment in an interactive inquiry-answering service. (Requires establishment of an indexing and storage element.)

Descriptions of these output forms are given in the following sections.

### Cut-and-Paste Output

The cut-and-paste output option is the least sophisticated output form considered. This form consists of a collection of pertinent items and articles assembled under a suitable cover passed directly to the user without analysis or comment. The mechanics involved are very simple, and, as noted in a later section, could be accomplished with minimum funding. Assuming that the information-collection operation (from whatever sources coverage might be selected) includes a culling or selection of items for pertinency, the first step required is the copying (e.g., Xerox) of articles.* The copying of abstracts or extracts might be deemed sufficient for some items. A second step is the grouping of items by related topics (or by some other scheme), if that is possible, and composing a suitable layout for an ordered presentation. The paste-up of items on layout sheets and the photoreduction (e.g., Xerox) of these sheets, if that might be required, is the next step. A final step would be the reproduction of the number of copies required from the master layout. Details of the operation would include such mechanics as the preparation of a cover sheet noting "To, From, Date, and Subject", checking that each item copied was fully identified regarding source, stapling or otherwise fastening cover and copy sheets together, and delivery to the user(s). Apart from the identification notations on the cover and articles, the cut-and-paste format would not include any comments or analytical remarks regarding item content. The frequency of issuance for cut-and-paste documents that might be prepared could be attuned to the volume of information becoming available consistent with program funding.

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* Permission to copy would be required for any material covered under copyright laws.

## Periodic Newsletter Output

An excellent example of the "Newsletter"-type output of information systems is the MCIC* Review of Metals Technology document issued weekly on a variety of topics, for example,"Refractory Metals, A Review of Selected Developments". These documents are designed to inform a user with interest in selected topics concerning pertinent literature, company activities, product availability, industry events, etc. Brief summaries of activities, data, and information are presented that are a step beyond mere abstracts or extracts of information, but are not in-depth analyses of events. The adaptation of this format to serve the EPA need is easily envisioned. The adaptation might be labeled Awareness Bulletin, Nonferrous Metals Technology (subtitle, An Analysis of Recent Developments) and contain write-ups regarding environmental implications of activities and information of recent vintage pertinent to the nonferrous metals interest of EPA.

An "Awareness Bulletin" of the above type could be prepared for issuance on a periodic basis to cover the technology revealed by the information collection operation. The following preparation steps are suggested:

(1) Selection of a number of the most meaningful documents, articles, and items of pertinence to the EPA nonferrous metals program based on the experienced judgment of the preparers as well as the "ground rules" that would be established by the user. (It should be noted that, although a selection process is inherent in the information-collection operation, an additional culling or selection process would probably be required to choose and limit, according to relevance, the items for presentation in a single issue of an "Awareness Bulletin".)

(2) Organization of information items according to topic or some other scheme and preparation of a draft text that would summarize the technology and present an analysis, including environmental implications. Based on the extent and availability of source data, quantitative treatment might be possible. However, in most cases, it is considered likely that only a modest qualitative analysis could be worked up. Technology summaries and analyses might cover single source items or several items. if several are found to describe a single related technology.

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* MCIC, Metals and Ceramics Information Center (DOD sponsored).

(3) Editorial and technical content of the draft text would be examined and corrected. Corrected text would be typed to conform to an appropriate format. Any figures and tabulations required to support the text would be drafted, corrected, and prepared as appropriate.

(4) Reproduction of the number of copies required for distribution. Depending on the number of copies desired, the "Awareness Bulletin" in "Newsletter" format might be reproduced in a simple typed form by Xerox or printed by some other photo process from compositype master copy, formalized masthead, etc. A fairly wide range of "Newsletter" styles is possible and the style that would be appropriate for the EPA effort in terms of user preference and funding considerations is selectable. Distribution of copies by mailing is the final operation.

## Topical In-Depth Reports

The in-depth state-of-the-art report and the topical analysis report are two of the more sophisticated output forms possible from an information system. We consider the draft report to EPA from the U.S. Bureau of Mines on "Environmental Considerations for Emerging Nonferrous Metal-Winning Processes" an example of such a report dealing with a narrow field of air pollution impacts in copper roasting, smelting, converting, and refining.

Additional examples of topical and analytical reports issued by MCIC have (1) reviewed the titanium industry in the mid-1970's presenting the state of the art in the technology of titanium production, metallurgy, availability, and utilization, and (2) analyzed related commodities (arsenic, asbestos, beryllium, and chromium chemicals) in terms of availability and utilization with emphasis on determining DOD dependence on the commodity.

The above reports did not depend solely on the published literature as a source for the information contained. It is, however, feasible to prepare an in-depth analytical report of the same type using only literature information sources. Naturally, a more comprehensive report could be prepared if a very broad source base were available, but, nevertheless, a rather thorough analysis could be conducted using only a limited base. We suggest the analytical report as one of the options of an EPA nonferrous metals information system which could be prepared from whatever information collection system was selected.

We further suggest that this option be considered as an "add-on" to the information system selected. That is, an in-depth analytical report might be appropriate as a result of information revealed by periodic literature searching and reporting. Separate funding for a topical report of this type could be tailored to allow the analyst to develop information from several sources, with the sources of the established information system serving as a base. An analyst working continuously in a particular field learns the best sources for information rather quickly, and, if the separate funding permitted, could enlist the assistance of specialists, make industry contacts, etc., to result in a very meaningful product stemming from the operations of the basic information system.

The need for a topical in-depth analytical report might develop according to the following hypothesis and could be prepared according to the procedures outlined.

(1) Information system reveals the development of a new technology which makes available a valuable by-product from a nonmetals operation (e.g., alumina from a shale oil conversion process).

(2) Information system over an extended time period reveals a continuous development of the technology, industrial investment, and the obvious forthcoming availability of large tonnages of alumina, apart from and in addition to the alumina produced by the aluminum industry.

(3) The forthcoming changes in the aluminum industry are apparent to EPA nonferrous metals personnel, who then request an in-depth analysis of the situation.

(4) Proposal prepared to cover the additional effort desired; proposal is accepted, task is negotiated, and work is started.

(5) Information search is intensified and expanded to most appropriate source areas. (The value of a preexisting file system as part of the total information system is, of course, apparent for an output of the topical report type.)

(6) Industry contacts are established, specialists are consulted, and other information sources (e.g., government agencies and industry associations personnel) are engaged to develop a comprehensive collection of data and information.

(7) The analysis--the report text, figures, and tables--is drafted and routed for approvals.

(8) The draft is corrected and report reproduction and distribution proceeds per standard procedures.

While the above appears to be precisely the procedure to be followed in satisfying the EPA requirements for any topical report, we suggest, that by building in suitable provisions in the contract establishing an information system (e.g., provisional funds that would not be expended unless mutually agreed upon for selected tasks), a very timely response could be achieved by analysts intimately familiar with the total system. We believe that the topical report option as an "add-on" feature of the total information system would be quite advantageous to EPA.

Interactive Inquiry Answering Service

Information systems of even the simplest kind are usually called upon to respond to queries from a variety of sources whether or not the system is formally prepared for such activity. Users or others who might have heard about the system ask a range of questions--from how to subscribe to the output services to technical inquiries. Invariably, questions on prior references are raised. Answers to inquiries may be provided which range from a response "off the top of the head" during a telephone conversation, to a rather detailed analytical commentary via letter. The latter is readily accomplished only if the information system is set up to provide this kind of output service.

The interactive inquiry answering capability is greatly facilitated, of course, by the existence of an information indexing and storage system. Such systems may range from the extremely simple (e.g., merely the memory of the information system operator) to the sophisticated (e.g., computer file) as described in a previous section. The mechanisms employed for information retrieval from storage also vary, as previously described, and are often the limiting factor in the response capability. Collectively, the indexing, storage, and retrieval elements of the information storage system need to be set up in the degree of complexity to fit the capabilities of the inquiry answering service planned.

The Battelle experience in the inquiry answering capability of information systems is wide ranging. A sophisticated information storage and retrieval system was developed for MCIC and its predecessor organizations with anticipation that the inquiry answering service was to be one of the most important output functions of the center. It was further anticipated (and confirmed during operations) that valuable information could be obtained from those placing inquiries, that users of an inquiry answering service were a first-rate information source, and that this interactive operational mode established the center as the focal point for information items that were otherwise inaccessible. The services rendered from this MCIC capability have ranged the full gamut, from the 5-minute telephone conversational answer drawing upon the memory of the information specialist, to the detailed literature search and analysis culminating in a comprehensive written response.

Another of the recent Battelle information centers maintained only a primitive storage file and usually dealt with inquiries received in corresponding degree. A complex inquiry received could not be handled routinely. In some instances, the complex inquiry was promoted (at the discretion of the sponsoring agency) to the rank of a separate task and answered in a comprehensive manner.

These experiences are cited to point out that inquiry answering services of an information center are quite common, either as a planned or unplanned function. However, since planning includes only a modest rate of effort to conduct the considered task, inquiry response would not be a significant service to be provided. Should the need develop to provide more than casual response to infrequent inquiries, provision of this service would require separate funding by the organization making the inquiry.

## SECTION 5

## THE OPTION MATRIX--RELATIVE RATES OF EFFORT REQUIRED

The several elements of an information system have been described in some detail in the preceding section to set the stage for the presentation of options for an EPA nonferrous metals system. We have described the various methodologies applicable to information collection, storage, analysis, and output forms falling within the constraints that we believe encompass the EPA needs and desires. That is, from the very wide range in scope and information coverages possible for the establishment of an information system, we have selected element choices believed most appropriate for EPA. These are presented in Table 1, as a matrix that gives a preliminary estimate of rates-of-effort for several operational options according to selected degrees of coverage of the periodical literature.

It should be clearly understood that the rates-of-effort estimates given in Table 1 are based on only a partial information sources coverage as obtained from only the periodical literature. The partial sources coverage base represents an arbitrary assumption that the periodical literature available would permit 80 percent coverage of all information available. Estimates were made based on the rates of effort required to include coverage of only that portion of the information base. Additional rates of effort would be required to cover additional information sources of the kinds suggested in Section 4, subsection on Information Sources and Input Methodology (e.g., symposia attendance, personal contact with industry and government specialists, etc.). These first-level estimates were based on early efforts, and were prepared for the exclusive purpose of assisting in the definition of preferred options to best meet EPA needs.

The option matrix given in Table 1 and the basis for its construction was discussed in considerable detail with the EPA Task Officer at about the middle of this task effort. The desirability of other sources of input (limited meeting attendance and visits) to supplement periodicals input also was discussed. As a result of this discussion, the EPA Officer selected as a guide to further refinement, a "Newsletter Output" matched to "moderate" coverage of the periodical literature as the best description of the EPA desires. Formal information indexing and storage necessary to a significant inquiry answering service and in-depth topical reports were judged to be beyond the scope of a refined task methodology. It was further agreed at this time that limited visitations at conferences and with industry and government specialists, and limited use of abstract services, would be useful as augmenting information sources.

From these mid-task guidelines and other discussions, specific recommendations for the awareness task were agreed upon and these are presented as the recommended options described in Section 7.

TABLE 1. THE OPTION MATRIX FOR AN INFORMATION SYSTEM TO SERVE THE NEEDS OF EPA REGARDING NONFERROUS METALS TECHNOLOGY[(a)]

| Periodic Literature Information Sources Coverage | Output Options[(b)] | | | | | |
|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | Combinations | |
| | Cut and Paste Output (No Storage)[(c)] | "Newsletter" Output (No Storage)[(c)] | Storage and Inquiry Answering Output[(c)] | Topical In-Depth Reports[(c)] | 1 + 3 | 2 + 3 |
| Minimal (~60 %) ~20 Periodicals | 600 | 1200 | 720 | 300 | 1320 | 1920 |
| Moderate (~75 %) ~40 Periodicals | 720 | 1440 | 800 | 400 | 1520 | 2240 |
| Maximum (~80 %) 60-70 Periodicals | 840 | 1620 | 840 | 400 to 2000 | 1680 | 2460 |

(a) Based only on input from periodical literature.

(b) Rate of effort estimates are given in man-hours per year (exclusive of G&A requirements).

(c) Output issues would be 12 per year for options 1 and 2, about 100 per year for option 3, and 1 per year for option 4.

# SECTION 6

# INFORMATION SOURCE SAMPLING

The primary effort on identification of information sources for the purpose of providing an awareness function regarding nonferrous metals technologies and their environmental implications was directed toward periodicals. A lesser effort was expended on identifying other information sources pertinent to the awareness task. An information source sampling exercise was conducted.

## PERIODICALS

### Basis for Selecting Candidate Periodicals

Both domestic and foreign publications were considered as candidate sources of information from which a select list of periodicals might be identified for pertinency to the awareness task. Initial candidate listings were obtained from metals oriented information centers operated within Battelle's Columbus Laboratories and from libraries serving Battelle and the USEPA. These rather extensive listings were evaluated by information specialists and project personnel to select periodicals which had been found to be the best sources of information (for various special purposes in prior work) or which appeared to be the most likely sources of information (e.g., selected foreign publications).

Specialists of the Copper Data Center, Metals and Ceramics Information Center, Iron Information Center, and Cobalt Information Center, provided gross lists of periodicals that are screened for their operations and identified select lists of documents which they have found to contain the bulk of the metals information. These select lists included some foreign publications (notably those published in the English language). An expanded preferred list of foreign periodicals was generated by a title screening operation performed by the EPA Project Officer (notably of publications from the Soviet Union and other Eastern European countries.

Collectively, candidate periodical listings covered the nonferrous metals technology reporting from Western Europe, Eastern Europe (including the Soviet Union), and Asia (including Australia), as well as U.S., British, and Canadian reporting. While African and South American periodicals were included, the coverage was not very extensive (2 periodicals from South America, 1 from Africa). Thus, total world coverage of nonferrous metal technology was believed to be provided on an initial consideration basis by these preliminary listings (entire list in alphabetical arrangement is given in Appendix A). It is recognized, of course, that additional periodicals of pertinence might be identified as an awareness task is developed through actual operating experience.

## Precursive Search and Tally Results

### Initial Search and Sampling Study--

A selected group of periodicals from the preliminary candidate listings was chosen for inclusion in a pilot study directed to ascertain, if possible, (1) documents which contain articles and/or items pertinent to the EPA awareness task, (2) best source documents in terms of number of pertinent articles/items, (3) frequency of occurrence of pertinent articles/items per a taxonomy and per document, and (4) nature of articles/items in terms of a metal versus process classification system. Documents selected for this study were foreign publications printed in English or having English tables of contents or English abstracts available, U.S., British, and Canadian publications identified as being probable sources of nonferrous metals information, and a few other selected documents. A total of 250 issues from 91 publications were examined (three issues per periodical where that was possible). The examination of these documents resulted in the identification of 529 items which appeared to be pertinent to the assessment task. The search and article identifications were based almost entirely on tables of contents information.

The relevant title search was conducted to determine the nature of articles and information items as well as frequency of occurrence per document. For this purpose, an elementary taxonomy was developed which consisted of groupings by metals (those that are commonly produced together as product--byproduct or as coproducts) and by metal production processing operations (e.g., mining, beneficiation, extraction, etc.). The results of the title search in terms of this taxonomy are given in Table 2. The data show that most information items could not be specifically classified per the title except in broad terms (multiple or unspecified categories). Also, most of the remaining items deal with copper, lead, or zinc technology (as might be expected considering the large relative production of these metals), and only a few items were relatable to the category of metal refining and ingot melting. The mining and beneficiation categories were well represented.

The results of the above analysis probably do not merit specific conclusions due to the limited sample size (in terms of time period covered) and to the possibility that distribution in categories varies widely from one time period to the next. Also, study of content of information items might result in some categorical changes. It does appear likely, however, based on this preliminary information, that coverage of most segments of metal processing in the nonferrous metals industry will be afforded by a literature search and that one could expect to find considerable information from the literature on almost any aspect of the industry selected.

TABLE 2. NUMBER AND PERCENT OF PERTINENT INFORMATION ITEMS FOUND BY CATEGORY (METAL SPECIES AND PROCESSING OPERATION)

| Item | Number of Information Articles/Items: U.S., British and Canadian Documents | Number of Information Articles/Items: Other Foreign Documents | Number of Information Articles/Items: Total | Total as Percent |
|---|---|---|---|---|
| Information Items by Metal Group | | | | |
| Copper, Cu (As, Se, Te) | 59 | 21 | 80 | 15.1 |
| Lead and Zinc, Pb and Zn (Sb, Tl, Cd) | 91 | 6 | 97 | 18.3 |
| Aluminum, Al (Ga) | 30 | 5 | 35 | 6.6 |
| Titanium, Ti (Zr, Hf) | 9 | 5 | 14 | 2.6 |
| Molybdenum, Mo (Sn) | 7 | 7 | 14 | 2.6 |
| Rare Earths and Radioactive (U, Th) | 16 | 5 | 21 | 4.0 |
| Beryllium, Be | 1 | 7 | 8 | 1.5 |
| Mercury, Hg | 5 | 0 | 5 | 0.9 |
| Precious Metals (Au, Ag, Pt) | 24 | 10 | 34 | 6.4 |
| Tungsten, W (V, Ta, Cb) | 5 | 1 | 6 | 1.1 |
| Magnesium, Mg | 6 | 0 | 6 | 1.1 |
| All Others and Multiple | 164 | 45 | 209 | 39.5 |
| Total | 417 | 112 | 529 | 100 |
| Information Items by Processing Operation[a] | | | | |
| Mining or Scrap Disposal and Collection | 93 | 23 | 116 | 21.9 |
| Beneficiation, Extraction, Smelting | 87 | 55 | 142 | 26.8 |
| Metal Refining and Ingot Melting | 25 | 12 | 37 | 7.0 |
| Multiple | 61 | 0 | 61 | 11.5 |
| Unspecified | 151 | 22 | 173 | 32.7 |
| Total | 417 | 112 | 529 | 100 |

[a] Both primary and secondary operations.

The results of the above pilot screening operation were analyzed to reveal several other interesting features of the information obtainable from periodicals. Of primary interest was the revelation that, within the select group of documents screened, 24 documents contained about 80 percent of all pertinent information items found. Forty documents contained about 93 percent. If it can be assumed that the three issues examined per document are truly representative of the content over an extensive time period, most of the information items available could be collected from as few as 50 documents.

The results of this initial screening of documents were given in Tables 5 and 6 of the Interim Report on this task, dated May 7, 1976. The results are included in this report as modified by an expanded study.

Expanded Search and Sampling Study--

The expanded document search conducted for the purpose of refining a preferred periodical list of most pertinence to an EPA awareness task was completed by including documents not previously examined and by assessing document pertinence by new, narrower criteria. In the initial screening study, all articles and information items having any relevance to the nonferrous metals processing area were counted as items of pertinence. The expanded study considered items pertinent only if they were concerned with the applied technology of nonferrous metals processing. A new information item tally based on the narrower criteria was not redone for documents examined initially but a supplemental rating system for documents was used to assess the value of these as well as the new documents examined.

The supplemental rating system involved assessment of documents in terms of their general character (e.g., mining equipment magazines were down-graded) and according to the nature of articles usually printed (e.g., theoretical or academic type versus practical types, physical metallurgy versus processing metallurgy, or ferrous versus nonferrous metallurgy). Also, the accessibility of information was considered (e.g., foreign language documents not possessing tables of contents in English were in general down-rated). A rating system of G (for Good), M (for Moderate interest), and X (for Unacceptable or of little interest) was adopted.

Based on the above qualitative methods of assessing documents, it was possible to eliminate from further consideration several documents which did not have contents applicable in any sense for the awareness task (these were given the X rating for unacceptable). On the other side, numerous documents were rated G (for Good) when the contents appeared to be of the type useful for the considered task. Documents with mixed contents, documents with contents not readily identifiable by titles only (e.g., foreign language articles), and documents revealing no items from this search, but still believed to be potential sources for information, were generally rated M.

The qualitative rating system was used in conjunction with the number of pertinent information items found to rank documents as an aid in determining a usefulness priority listing. Documents rated G were assigned a high rank, those rated M a lower rank, etc. Within G, M, and X groups, rank was determined and assigned by the number of pertinent items found. According to this system, a few documents having several information items were given a low priority because they were X-rated due to the nature of articles. Conversely, a few documents were rated Good even though only one or no useful information items were found in the issues screened. The system was intended to permit the selection of a preferred periodicals list which is discussed in the next section. The listings in this section merely present the results of the expanded search and screening study.

U.S., British, and Canadian Periodicals--The pilot screening of U.S., British, and Canadian periodicals was expanded to include several publications not screened initially. Three issues from each periodical were examined only if the nature of articles or general character of the document in the first issue looked at appeared to have pertinence. The periodicals examined in the initial screening for the number of contained articles/items having pertinency were reexamined and rated for general character. The expanded list of U.S., British, and Canadian periodicals is given in Table 3 in an order of priority based on the combined rating and ranking system previously described. (The entire list of periodicals examined, including U.S., British, Canadian, and other foreign publications, is given in alphabetical arrangement in Appendix A as previously mentioned.)

The listing in Table 3 totals 93 periodicals. Only 19 documents were rated G from this total based on the criteria previously described. Twenty-two (22) periodicals received the M rating while more than half the total, 52 documents, were X-rated. Within the G-rated group, the number of pertinent items found ranged from 23 (top ranked) to 0 (ranked 48 because foreign language periodicals were included in the total ranking order). Pertinent items found for M-rated periodicals ranged from 18 to 0. X-rated documents had a range of 14 to 0 items. Numbers of items found per document were obviously of less importance than the kind of items found and/or the character of the periodical. Further, it should be understood that items found within a single periodical are not of equal value. For example, the tenth ranked document having 12 items might have only 1 or 2 items of substance, 2 of moderate interest, and the balance of marginal value. Thus, the ranking order assigned to documents is quite arbitrary but serves for initial guidance prior to and in lieu of article/document use in actual operational experience.

After the initial pilot screening study, an analysis of the data was made based on the number of information items found to show that about 80 percent of items based on total items found were found in the top-ranked 40 documents. Based on the new criteria, this kind of analysis is considered to have little meaning. However, the new rating and ranking system indicates that about 24 top rated and ranked U.S., British, and Canadian periodicals continue to contain the bulk of the most useful information with another 10 or so documents containing information of more moderate interest and usefulness. Thus, both the initial and the expanded screening studies showed that 30-some periodicals should be considered as the primary source

### TABLE 3. RANK ORDER LISTING OF UNITED STATES, BRITISH AND CANADIAN PERIODICALS EXAMINED FOR PERTINENCY TO AWARENESS TASK

| Document Title | No. Items(a) Found In | | | | Rate(b) | Rank(c) | ID(d) Nos. |
|---|---|---|---|---|---|---|---|
| | A | B | C | Sum | | | |
| Mining Journal | 8 | 7 | 8 | 23 | G | 2 | 520 |
| Society of Mining Engineers, Transactions (AIME) | 9 | 2 | 8 | 19 | G | 4 | 380 |
| Journal of Metals (AIME) | 1 | 1 | 12 | 14 | G | 7 | 500 |
| Mining Congress Journal | 4 | 7 | 2 | 13 | G | 8 | 250 |
| American Metal Market | 4 | 4 | 4 | 12 | G | 10 | 100 |
| Skillings Mining Review | 2 | 3 | 1 | 6 | G | 18 | 280 |
| Metal Week | 3 | 1 | 0 | 4 | G | 20 | 620 |
| 33-Magazine, Metal Producing | 2 | 1 | 1 | 4 | G | 23 | 420 |
| Trans. Institute of Mining and Metallurgy, Section B | 1 | 1 | 2 | 4 | G | 25 | 1002 |
| Canadian Mining and Metallurgical Bulletin | 1 | 1 | 1 | 3 | G | 27 | 140 |
| Journal of The Air Pollution Control Association | 1 | 1 | 1 | 3 | G | 28 | 200 |
| Canadian Mining Journal | 0 | 1 | 1 | 2 | G | 34 | 130 |
| Canadian Metallurgical Quarterly | 1 | 1 | 0 | 2 | G | 35 | 120 |
| Iron Age | 1 | 0 | 1 | 2 | G | 36 | 180 |
| Trans. Institute of Mining and Metallurgy, Section C | 1 | 0 | 0 | 1 | G | 45 | 1003 |
| Environmental Science and Technology | 0 | 0 | 1 | 1 | G | 46 | 1000 |
| Trans. Institute of Mining and Metallurgy, Section A | 0 | 0 | 0 | 0 | G | 47 | 1001 |
| Journal of Hazardous Materials | 1 | 0 | 0 | 1 | G | 48 | 1070 |
| Paydirt(e) | | | | | G | 49 | 1080 |
| Hydrometallurgy | 4 | 10 | 4 | 18 | M | 50 | 1006 |
| Mining Magazine | 3 | 5 | 3 | 11 | M | 51 | 270 |
| Metallurgical Transactions (ASM, AIME) Section B | 3 | 6 | 0 | 9 | M | 52 | 320 |

(continued)

TABLE 3. (Continued)

| Document Title | No. Items[(a)] Found In A | B | C | Sum | Rate[(b)] | Rank[(c)] | ID Nos.[(d)] |
|---|---|---|---|---|---|---|---|
| Engineering and Mining Journal | 3 | 2 | 3 | 8 | M | 53 | 150 |
| Journal of The Water Pollution Control Federation | 1 | 2 | 1 | 4 | M | 55 | 210 |
| Wall Street Journal | 2 | 0 | 2 | 4 | M | 55 | 390 |
| Mining Engineering | 4 | 0 | 0 | 4 | M | 57 | 230 |
| Industry Week | 1 | 1 | 1 | 3 | M | 61 | 160 |
| Foundry Trade Journal | 1 | 1 | 1 | 3 | M | 62 | 480 |
| Chemical and Engineering News | 1 | 0 | 1 | 2 | M | 64 | 440 |
| Business Week | 1 | 1 | 0 | 2 | M | 65 | 110 |
| Barrons Business and Financial Weekly | 0 | 0 | 2 | 2 | M | 67 | 410 |
| The Mine Magazine | 1 | 0 | 0 | 1 | M | 68 | 1004 |
| Water Air and Soil Pollution | 1 | 0 | 0 | 1 | M | 70 | 1005 |
| Journal of The American Water Works Association | 0 | 0 | 1 | 1 | M | 75 | 190 |
| Modern Metals | 0 | 0 | 1 | 1 | M | 76 | 310 |
| Water and Wastes Engineering | 1 | 0 | 0 | 1 | M | 77 | 350 |
| Research/Development | 0 | 0 | 1 | 1 | M | 78 | 300 |
| Modern Castings | 1 | 0 | 0 | 1 | M | 83 | 630 |
| Mineral Research Bulletin | 0 | 0 | 0 | 0 | M | 84 | 490 |
| Separation Science | 0 | 0 | 0 | 0 | M | 96 | 290 |
| Metals Technology | 0 | 0 | 0 | 0 | M | 99 | 660 |
| Filtration and Separation | 7 | 3 | 4 | 14 | X | 103 | 470 |
| Industrial Water Engineering | 4 | 5 | 4 | 13 | X | 104 | 510 |
| Mine and Quarry | 1 | 4 | 4 | 9 | X | 106 | 260 |
| Foundry Management and Technology | 1 | 2 | 1 | 4 | X | 107 | 460 |
| Metals and Materials | 4 | 0 | 0 | 4 | X | 108 | 560 |
| Water Research | 2 | 2 | 0 | 4 | X | 109 | 360 |
| Chemical Week | 0 | 0 | 0 | 0 | X | 110 | 430 |
| Engineer | 0 | 0 | 0 | 0 | X | 111 | 450 |

(continued)

TABLE 3. (Continued)

| Document Title | No. Items(a) Found In A | B | C | Sum | Rate(b) | Rank(c) | ID(d) Nos. |
|---|---|---|---|---|---|---|---|
| Metallurgical Transactions (ASM, AIME) Section A | 0 | 0 | 0 | 0 | X | 112 | 330 |
| The British Foundryman | 0 | 0 | 0 | 0 | X | 117 | 570 |
| Critical Reviews in Environmental Control | 0 |  |  | 0 | X | 118 | 580 |
| Engineering | 0 | 0 | 0 | 0 | X | 119 | 590 |
| Engineering Materials and Design | 0 | 0 | 0 | 0 | X | 120 | 600 |
| Metal Construction | 0 | 0 | 0 | 0 | X | 121 | 640 |
| Metal Science | 0 | 0 | 0 | 0 | X | 122 | 650 |
| International Metallurgical Reviews | 0 | 0 | 0 | 0 | X | 124 | 680 |
| Welding Design and Fabrication | 0 | 0 | 0 | 0 | X | 125 | 690 |
| Water and Pollution Control | 0 | 0 | 0 | 0 | X | 126 | 700 |
| Canadian Research and Development | 0 | 0 | 0 | 0 | X | 127 | 710 |
| Design Engineering | 0 | 0 | 0 | 0 | X | 128 | 720 |
| Modern Power and Engineering | 0 | 0 | 0 | 0 | X | 129 | 730 |
| Acta Metallugica | 0 | 0 | 0 | 0 | X | 130 | 740 |
| Air Conditioning, Heating and Refrigeration | 0 |  |  | 0 | X | 131 | 750 |
| American Machinist |  |  |  |  | X | 158 | 760 |
| Assembly Engineering |  |  |  |  | X | 159 | 770 |
| Automatic Machining |  |  |  |  | X | 160 | 780 |
| Welding Journal |  |  |  |  | X | 162 | 1060 |
| Tooling and Production |  |  |  |  | X | 164 | 1040 |
| Sea Technology |  |  |  |  | X | 166 | 1020 |
| Rubber World |  |  |  |  | X | 167 | 1010 |
| Rubber Chemistry and Technology |  |  |  |  | X | 168 | 1005 |
| Product Engineering |  |  |  |  | X | 169 | 990 |
| Polymer Engineering and Science |  |  |  |  | X | 170 | 980 |
| Ocean Engineering |  |  |  |  | X | 171 | 970 |

(continued)

TABLE 3. (Continued)

| Document Title | No. Items[a] Found In |  |  |  | Rate[b] | Rank[c] | ID[d] Nos. |
|---|---|---|---|---|---|---|---|
|  | A | B | C | Sum |  |  |  |
| Mechanical Engineering |  |  |  |  | X | 172 | 960 |
| Materials Science and Engineering |  |  |  |  | X | 173 | 950 |
| Materials Evaluation |  |  |  |  | X | 174 | 940 |
| Materials Engineering |  |  |  |  | X | 175 | 930 |
| Machine Design |  |  |  |  | X | 176 | 920 |
| Journal of Pressure Vessel Technology (ASME Trans.) |  |  |  |  | X | 177 | 910 |
| Journal of Heat Transfer (ASME Transactions) |  |  |  |  | X | 178 | 900 |
| Journal of Applied Physics |  |  |  |  | X | 179 | 890 |
| Journal of Applied Mechanics (ASME Transactions) |  |  |  |  | X | 180 | 880 |
| Inorganic Chemistry |  |  |  |  | X | 181 | 870 |
| IEEE Transactions on Power Apparatus and Systems |  |  |  |  | X | 182 | 860 |
| Heating, piping and Air Conditioning |  |  |  |  | X | 183 | 850 |
| Corrosion Science |  |  |  |  | X | 184 | 840 |
| Corrosion |  |  |  |  | X | 185 | 830 |
| Control Engineering |  |  |  |  | X | 186 | 820 |
| Canadian Journal of Physics |  |  |  |  | X | 187 | 810 |
| Canadian Journal of Chemistry |  |  |  |  | X | 188 | 800 |
| Bell Labs Record |  |  |  |  | X | 189 | 790 |

(a) The second, third, fourth, and fifth columns (A, B, C, and SUM, respectively) represent the numbers of pertinent information items found in the search of periodical issues.

(b) The sixth column (RATE) indicates an overall value of the document to the awareness task. G = Good, M = Moderate interest, X = Little or No interest.

(c) The seventh column (RANK) indicates priority order based on number of information items found per document. RANK is subordinate to RATE. All documents examined are included in the RANK order (i.e., Domestic and Foreign publications).

(d) The eighth column (ID NOS.) indicates an internal identification number.

(e) Issues not examined but document is known to be pertinent to the awareness task.

of information for the considered task. This aspect of the study is further described in the following section where a preferred periodical list is presented.

Foreign Published Periodicals--The foreign published periodical listings were expanded with the aim of identifying better coverage of foreign nonferrous metals technology than identified in the initial screening. (British, and Canadian publications were considered with the listing of U.S. publications.) Accordingly, several additional foreign periodicals were examined using the new criteria previously described as assessment tools. An additional complicating factor in this study was the foreign language barrier. It was difficult to assess the overall character of documents and in some cases, the nature of articles, based on translated titles as the only guide. Nevertheless, within the difficulties cited, periodicals from each of the major world segments of the nonferrous metals communities were examined and assessed. The rating and ranking system previously described was used with the results given in Table 4.

Of the 90-some documents listed in Table 4, about one-third are rated G, one-third M, and balance X (G-31, M-31, X-31). Pertinent items found for G-rated periodicals ranged from 26 to 1, M-rated documents from 5 to 0, and X-rated periodicals contained no identified items of interest. The two documents from Yugoslavia were not rated because current issues were not available for examination. Numbers of items found per document were of more importance in evaluating foreign language periodicals than in evaluating U.S., British, and Canadian documents because of the difficulty in determining nature of items from titles only and the character of documents generally. Nevertheless, the rank order presented in Table 4 reflects an attempt at the latter which stands in need of considerable refinement during actual operations. The rank ordering is arbitrary but serves to aid in initially selecting periodicals for a preferred list of foreign documents as information sources for the considered task.

In considering coverage of the world's important segments which may be generating information on nonferrous metals technology, attention was directed to the areas of Western Europe, Eastern Europe (including the Soviet Union), Asia (including Australia), Africa, and South America. As revealed in the tally (Table 4), the document coverage for individual countries within the above areas was as indicated below.

For Western Europe: West Germany 13 documents, France 8, Sweden 4, Netherlands 2, Italy 2, and 1 each from Belgium, Switzerland, Norway, and Finland (total 33).

The relative scarcity of pertinent periodicals from the Western European community makes it difficult to screen for good coverage of nonferrous metals technology being practiced in or emerging from this area. However, it was stated by persons who have lived and worked in this area in a technical capacity that pertinent articles by West European authors are as frequently published in U.S., British, or Canadian journals as in their native publications. Nevertheless, there were 7 periodicals (3 from West Germany, 2 from

## TABLE 4. RANK ORDER LISTING OF FOREIGN PUBLICATIONS EXAMINED FOR PERTINENCY TO AWARENESS TASK

| Document Title | No. Items(a) Found In A | B | C | Sum | (b) Rate | (c) Rank | ID(d) Nos. |
|---|---|---|---|---|---|---|---|
| Izvestiya, VUZ, Tsvetnaya Metallurgiya (USSR) | 6 | 13 | 7 | 26 | G | 1 | 2 |
| Tsvetnyye Metally (USSR) | 12 | 10 |  | 22 | G | 3 | 77 |
| Trudy Inst. Metallurgii I Obogashcheniia Acad. Nauk, Kazakh, SSR | 8 | 6 | 4 | 18 | G | 5 | 78 |
| Rudodobiv (Bulgaria) | 6 | 6 | 3 | 15 | G | 6 | 67 |
| Erzmetall (Germany) | 6 | 4 | 3 | 13 | G | 9 | 18 |
| International Journal of Mineral Processing (Neth.) | 6 | 2 | 2 | 10 | G | 11 | 25 |
| Metall (Germany) | 2 | 5 | 1 | 8 | G | 12 | 20 |
| Minerals Science and Engineering (South Africa) | 4 | 3 |  | 7 | G | 13 | 33 |
| Neue Hutte (East Germany) | 0 | 2 | 5 | 7 | G | 14 | 50 |
| Rudy I Metale Niezelazne (Poland) | 3 | 3 | 1 | 7 | G | 15 | 71 |
| World Mining (Australia) | 3 | 2 | 2 | 7 | G | 15 | 37 |
| Australasian Institute of Mining And Metallurgical Processing | 2 | 2 | 2 | 6 | G | 16 | 34 |
| Nat. Metallurgical Lab. Tech. Journal (India) | 0 | 6 | 0 | 6 | G | 17 | 40 |
| Bul. Res. Inst. Mineral Dressing and Met., Tohoku Univ. | 2 | 0 | 3 | 5 | G | 19 | 85 |
| Australian Mining | 0 | 2 | 2 | 4 | G | 21 | 35 |
| Giesserei (Germany) | 1 | 3 | 0 | 4 | G | 22 | 41 |
| Archiwum Hutnictwa/Pan (Poland) | 2 | 1 | 1 | 4 | G | 24 | 5 |
| Australasian Corrosion Engineering | 0 | 1 | 2 | 3 | G | 26 | 36 |
| Ochrona Powietrza (Poland) | 3 |  |  | 3 | G | 29 | 8 |
| Doklady Akademii Nauk (USSR) | 1 | 0 | 1 | 2 | G | 30 | 79 |
| Banyasyaii Es Kohazati Lapok-Kohaszat (Hungary) | 2 | 0 | 0 | 2 | G | 31 | 64 |

(continued)

TABLE 4. (Continued)

| Document Title | No. Items Found In[a] |  |  |  |  |  |  |
|---|---|---|---|---|---|---|---|
|  | A | B | C | Sum | Rate[b] | Rank[c] | ID Nos.[d] |
| Transactions Of The Indian Institute of Metals | 0 | 2 | 0 | 2 | G | 32 | 82 |
| Indian Journal of Technology | 0 | 0 | 2 | 2 | G | 33 | 38 |
| Metalurgia (Rumania) | 1 | 0 | 1 | 2 | G | 37 | 10 |
| Czechoslovak Heavy Industry | 0 | 1 | 1 | 2 | G | 38 | 3 |
| Hungarian Heavy Industry | 0 | 1 | 1 | 2 | G | 39 | 4 |
| Trans. of The Nat. Research Inst. For Metals (Japan) | 1 | 0 | 0 | 1 | G | 40 | 91 |
| Banyasyaii Es Kohazati Lapok-Ontode (Hungary) | 1 | 0 | 0 | 1 | G | 41 | 65 |
| Hutnicke Listy (Czechoslovakia) | 0 | 1 | 0 | 1 | G | 42 | 61 |
| Scandinavian Journal of Metallurgy (Sweden) | 1 | 0 | 0 | 1 | G | 43 | 29 |
| Hitachi Review (Japan) | 0 | 1 | 0 | 1 | G | 44 | 84 |
| Problemy Projektowo Hutnictwa I Przemyslu Maszynowego (Poland) | 2 | 2 | 1 | 5 | M | 54 | 70 |
| Indian And Eastern Engineer | 2 | 2 | 0 | 4 | M | 58 | 81 |
| Izvestiya Acad. Nauk USSR, Metally | 3 | 1 |  | 4 | M | 59 | 73 |
| Metallurgia ABM (Brazil) | 1 | 1 | 1 | 3 | M | 60 | 31 |
| Gieszereitechnik (Germany) | 1 | 0 | 1 | 2 | M | 63 | 19 |
| Spisanie Na Bulgarskoto Geologichesko Druzhestvo (Bulgaria) | 1 | 0 | 1 | 2 | M | 66 | 68 |
| Kinzoku (Japan) | 1 | 0 | 0 | 1 | M | 69 | 15 |
| IHI Engineering Review (Japan) | 0 | 0 | 1 | 1 | M | 71 | 12 |
| Inzynieria Chemiczna (Poland) | 1 | 0 | 0 | 1 | M | 72 | 7 |
| Prace Instytutow Hutniczych (Poland) | 0 | 0 | 1 | 1 | M | 73 | 9 |
| Fonderia (Italy) | 1 | 0 | 0 | 1 | M | 74 | 21 |
| Radex Rundschau (Germany) | 1 | 0 | 0 | 1 | M | 79 | 45 |
| Banyasyaii Es Kohazati Lapok-Banyaszat (Hungary) | 1 | 0 | 0 | 1 | M | 80 | 63 |

(continued)

TABLE 4. (Continued)

| | No. Items(a) Found In | | | | | | |
|---|---|---|---|---|---|---|---|
| Document Title | A | B | C | Sum | Rate(b) | Rank(c) | ID(d) Nos. |
| Hutnik (Czechoslovakia) | 1 | 0 | 0 | 1 | M | 81 | 62 |
| Hutnik (Poland) | 0 | 0 | 0 | 0 | M | 85 | 6 |
| La Metallurgia Italiana (Italy) | 0 | 0 | 0 | 0 | M | 86 | 22 |
| Journal Of The Japan Institute Of Metals | 0 | 0 | 0 | 0 | M | 87 | 14 |
| Iron Age Metalworking International (Neth.) | 0 | 0 | 0 | 0 | M | 88 | 26 |
| Journal of Scientific and Industrial Research (India) | 0 | 0 | 0 | 0 | M | 89 | 39 |
| Revue Les Meoires Scientifiques De La Revue De Metallurgie | 0 | 0 | 0 | 0 | M | 90 | 24 |
| NKG Transactions Of The Japan Institute Of Metals | 0 | 0 | 0 | 0 | M | 91 | 83 |
| Comptes Rendus Hebdomadaires Des Seances L Acad. Sciences, B | 0 | 0 | 0 | 0 | M | 92 | 56 |
| Journal Faculty of Engineering, Tokyo Univ., Series A | 0 | 0 | 0 | 0 | M | 94 | 93 |
| Sumitomo Metals (Japan) | 0 | 0 | | 0 | M | 95 | 89 |
| Journal Faculity Of Engineering, Tokyo Univ., Series B | 0 | 0 | 0 | 0 | M | 97 | 94 |
| Wiadmosci Hutnicze (Poland) | 0 | 0 | 0 | 0 | M | 98 | 72 |
| Science Reports Research Inst., Tohoku Univ., Series A | 0 | 0 | 0 | 0 | M | 100 | 92 |
| Trade Times, Japanese Machinery Exporters Assoc. Bulletin | 0 | 0 | 0 | 0 | M | 101 | 88 |
| Report Inst. Of Industrial Science, Tokyo Univ. | 0 | 0 | | 0 | M | 102 | 95 |
| Metallurgicheskaya I Gornorudnaya Promyshlennost (USSR) | 0 | 0 | | 0 | M | 105 | 76 |
| Comptes Rendus Hebdomadaires Des Seances L Acad. Sciences, D | 0 | 0 | 0 | 0 | M | 123 | 55 |
| Revue De Metallurgie (France) | 0 | 0 | 0 | 0 | X | 137 | 23 |

(continued)

TABLE 4. (Continued)

| Document Title | No. Items Found In[a] | | | | | | |
|---|---|---|---|---|---|---|---|
| | A | B | C | Sum | Rate[b] | Rank[c] | ID Nos[d] |
| Revista Latinoamericana De Siderurgia (Chile) | 0 | 0 | 0 | 0 | X | 139 | 32 |
| Revue De L Aluminim (France) | 0 | 0 | 0 | 0 | X | 146 | 57 |
| Revue International Hautes Temp. Refracktaires (France) | 0 | 0 | 0 | 0 | X | 147 | 58 |
| Revue Generale Des Techniques La Metal. Const. Mech. (France) | 0 | 0 | 0 | 0 | X | 148 | 60 |
| Hansa (Germany) | | | | | X | 152 | 49 |
| La Fonderia Belge (Belgium) | 0 | 0 | 0 | 0 | X | 113 | 27 |
| Prometal (Switzerland) | 0 | 0 | 0 | 0 | X | 114 | 30 |
| Fizika Metallov I. Metallovedeniye (USSR) | 0 | 0 | 0 | 0 | X | 115 | 1 |
| National Technical Report (Japan) | 0 | 0 | 0 | 0 | X | 116 | 13 |
| Materialno-Tekhnichesko Snaboyavane (Bulgaria) | 0 | 0 | 0 | 0 | X | 132 | 66 |
| Metallurg (USSR) | 0 | 0 | | 0 | X | 133 | 75 |
| The Sumitomo Search (Japan) | 0 | 0 | 0 | 0 | X | 134 | 90 |
| Tetsu-To-Hagane (Japan) | 0 | 0 | 0 | 0 | X | 135 | 16 |
| Electrowarme-International (Germany) | 0 | 0 | 0 | 0 | X | 136 | 17 |
| Jernkontorets Annaler (Sweden) | 0 | 0 | 0 | 0 | X | 138 | 28 |
| Giesserei Forschung (Germany) | 0 | 0 | 0 | 0 | X | 140 | 42 |
| VDI Zeitschrift (Germany) | 0 | 0 | 0 | 0 | X | 141 | 43 |
| VGB Kraft Werkstechnik (Germany) | 0 | 0 | 0 | 0 | X | 142 | 44 |
| Sprechsaal (Germany) | 0 | 0 | 0 | 0 | X | 143 | 46 |
| Industriell Teknik (Sweden) | 0 | 0 | 0 | 0 | X | 144 | 52 |
| Kjemi (Sweden) | 0 | 0 | 0 | 0 | X | 145 | 54 |
| Verres Et Refractaires (France) | | | | | X | 149 | 59 |
| Teknikens Vorld (Sweden) | | | | | X | 150 | 53 |
| Ilmailu (Finland) | | | | | X | 151 | 51 |
| MBB-Aktjell (Germany) | | | | | X | 153 | 48 |

(continued)

TABLE 4. (Continued)

| Document Title | No. Items Found In[a] A | B | C | Sum | Rate[b] | Rank[c] | ID Nos.[d] |
|---|---|---|---|---|---|---|---|
| DFVLR Nachrichten (Germany) | | | | | X | 154 | 47 |
| Zaschita Na Prirodata (Bulgaria) | | | | | X | 155 | 69 |
| Kokubo (Japan) | | | | | X | 156 | 86 |
| Shin Boei Ronshu (Japan) | | | | | X | 157 | 87 |
| Metallovedeniya I Termicheskaya Obrabotka Metallov (USSR) | 0 | 0 | | 0 | X | 190 | 74 |
| Science Of Sintering (Yugoslavia) | | | | | | | 11 |
| Metalurgija (Yugoslavia) | | | | | | | 80 |

(a) The second, third, fourth, and fifth columns (A, B, C, and SUM, respectively) represent the numbers of pertinent information items found in the search of periodical issues.

(b) The sixth column (RATE) indicates an overall value of the document to the awareness task. G = Good, M = Moderate interest, X = Little or No interest.

(c) The seventh column (RANK) indicates priority order based on number of information items found per document. RANK is subordinate to RATE. All documents examined are included in the RANK order (i.e., Domestic and Foreign publications).

(d) The eighth column (ID NOS.) indicates an internal identification number.

the Netherlands, and 1 each from Sweden and France) that appeared to afford the most appropriate coverage of the topics of interest from this area and these are described in the following section.

The periodicals coverage for Eastern Europe was: Soviet Union 10, Poland 8, Hungary 4, Bulgaria 4, Czechoslovakia 3, Yugoslavia 2 (neither was available for examination), and 1 each from Rumania and East Germany (total 33). Thus, the coverage of Eastern European technology appears excellent based on the number of documents having apparent pertinent articles. A total of 11 periodicals (3 from the Soviet Union, 2 each from Poland, Hungary, and Czechoslovakia, and 1 each from Bulgaria and East Germany) appeared to afford appropriate coverage from this area and these are described in the following section. In selecting periodicals for a recommended listing, an attempt was made to minimize the translation problem by choosing mostly documents having tables of contents or abstracts in English. The most pertinent articles as identified during the actual operation of an awareness task would often require translation of the entire article which has been considered in the description in the following section.

The periodicals coverage for Asia was: Japan 18, India 5, and Australia 4 (total 27). The Indian and Australian documents are all published in English and most are apparently of good pertinency. Most of the Japanese periodicals examined (11) also are published in English, but several of these were found to be of no interest or of marginal interest. Two Japanese documents published in English and having apparent pertinency were selected for the preferred periodical list together with one having English table of contents and one wholly in Japanese. These four from Japan, and three each from India and Australia constitute the periodicals for Asian coverage and are included in the preferred list described in the following section.

A single document from Africa and two documents from South America (one each from Brazil and Chile) were examined. It is apparent that the Chilian journal should be eliminated from consideration (wholly dealing with iron and steel) and that the Brazilian and African documents should be listed (the South African journal is in English). The coverage of the South American technology appears inadequate but perhaps better journals can be identified during operation of an awareness task. The Brazilian and South African periodicals are included in the preferred list described in the following section.

## ABSTRACTS AND OTHER INFORMATION SERVICES

Abstract documents were sampled to determine the value of this kind of information source for an awareness task. From the list of abstracts identified as being locally available, which included Chemical Abstracts, Copper Abstracts, Lead Abstracts, Selenium and Tellurium Abstracts, and Zinc Abstracts, the Chemical, Lead, and Selenium/Tellurium abstract documents were screened. The Lead Abstracts issues examined (three) contained a total of 72 items of apparent pertinency, the single issue of Chemical Abstracts looked at contained 68 items, and the three issues of Selenium and Tellurium Abstracts, a total of only 2 items. Thus, a great variation exists in the value of abstract documents based on the number of pertinent items contained. Of overriding importance, however, is the lack of currency of items in these documents. The lag apparently varies from 3 to 6 months. It would appear appropriate to cover the abstract literature to some extent for the purpose of providing a check on the coverage of information items obtained from periodicals.

In addition to the abstracts examined, three issues of the Official Gazette (U.S. Patents) were examined. A total of 27 possibly pertinent patents were identified from the three issues of this document which appears on a weekly basis. A disproportionate period of time was needed to screen three issues (compared with the time required to screen tables of contents of regular periodicals). Nevertheless, it would appear necessary to include the patent coverage if the awareness function is to be fully served.

The Committee on Materials (COMAT), a federal activity, authorized the development of a pilot inventory of Government sponsored materials R & D programs. This inventory, which was developed at Battelle, is contained as a module of the Battelle-Columbus BASIS capability. It was accessed to provide a sampling of FY 76 R & D activity of potential interest to the task. Three listings were retrieved. The first was derived by calling for current programs dealing with metal ores or nonferrous metals in the fields of activity of mine development, mining, processing of raw materials (including beneficiation, leaching, roasting, smelting, refining, etc.), or the management of wastes. This first retrieval returned a list of 25 programs, of which 23 involved the technology of nonferrous metals or their ores (two were concerned only with iron resources or processing). All but two were Bureau of Mines programs. One was an EPA program and the other was funded by the Air Force. This program list is contained in Appendix B under PRINT 9.

A second list was specified by selecting from the first list those programs that have as one aspect of the work the reduction of pollutants from nonferrous metallurgical processes. Two programs were defined. These appear in Appendix B under PRINT 11. For one of these, an additional retrieval specification was that the reason for conducting the program was for the control of environmental quality. This record, the EPA program, is displayed in Appendix B under PRINT 13.

In this example, the effort required to develop the search strategy, access the data base, conduct the search, and pick up the printout involved about 1 hour of an analyst's time. Remote terminal connect time was 7 minutes, and computer costs were $4.21. This was done by an analyst with intimate knowledge of the data base and also precise knowledge of what was desired from the search. The example is cited to illustrate the simplicity of searching existing data bases. The example was also useful in identifying the Bureau of Mines (not unexpectedly) as the Government agency that is most active in R & D activities relating directly to the interests of the awareness task.

## COMPANY ANNUAL REPORTS

In addition to the formal published literature, a sampling of 10 company annual reports was made. The companies were selected from among those whose principal business is primary nonferrous metals. Perusal of these revealed that 7 of the 10 reports provided potentially useful statements and information, and 4 of the 10 contained more than one item of probable interest. Company reports are only put out on an annual basis which would somewhat limit the volume of information obtainable from this source. Nevertheless, it is recommended that selected annual reports be reviewed for input. The Dunn and Bradstreet Million Dollar Directory lists 245 entries under SIC categories from 1021 (Copper Ores) to 1099 (Metal Ores, n.e.c.), 3313 (Electrometallurgical Products), 3331 (Primary Smelting and Refining; Copper) through 3339 (Nonferrous Metals, n.e.c.), 3341 (Secondary Refining of Nonferrous Metals). Included are companies such as Cypress, Anaconda, Phelps Dodge, ASARCO, St. Joe, Cominco, Homestake, Silver King, AMAX, Union Carbide, Olin, Kennecott, Kaiser, Alumax, Alcoa, Conalco, Englehard, Brush Wellman, Oremet, Materials Research Corp., Bay State, Eastern Alloys, Matthey Bishop, etc. Many of these report under multiple SIC areas. The Battelle Economics Library maintains files of annual reports for many of these companies.

# SECTION 7

# DESCRIPTION OF RECOMMENDED OPTIONS

## INTRODUCTION

The numerous options available regarding the input-output elements of an information system were described in preceding sections of the report and presented in terms of level-of-effort requirements in Table 1. The data in Table 1 show the relative sizing of combinations of various input and output forms. During the course of this task, the project officer was briefed regarding these options and level-of-effort requirements. This interaction between the project officer and Battelle afforded the project officer an opportunity to identify preferred elements capable of serving the awareness function. Stated preferences permitted Battelle personnel to focus attention in these areas and to design a specific information system around them.

This section reflects the stated preferences in the description of the input-output options being recommended for the awareness task. Briefly, the recommended system would consist of inputs from periodicals, abstracts, company reports, and information obtained from symposia and personal communications. The principal output would be in the form of a newsletter or an "Awareness Bulletin". This would describe the trends or potential changes in nonferrous metals technology (or other information) involved and consider the actual or potential environmental implications of such technology. An output option of topical reports is suggested for consideration as an add-on to the basic system should the need for in-depth studies to augment the awareness function become apparent.

## INFORMATION SOURCES

The principal source of information recommended for the awareness task should be periodicals. The prior experience of Battelle with metal information centers and the specific pilot screening studies conducted for this task have permitted the identification of a preferred group of documents which should be searched for information on a regular basis. The list of periodicals recommended for source material per the awareness task is given in Tables 5 and 6.

This group of documents is believed to offer the bulk of the reportable coverage on the nonferrous metals industries on a world basis with emphasis on U.S. technology. Sampling studies have shown that the important

## TABLE 5. PERIODICALS RECOMMENDED AS INFORMATION SOURCES FOR THE USEPA AWARENESS TASK

(Domestic and Foreign Publication Subgroups Listed in Priority Order)

| Document Title | No. Items(a) Found In A | B | C | Sum | Rate(b) | Rank(c) | ID(d) Nos. |
|---|---|---|---|---|---|---|---|
| **United States, British and Canadian Periodicals** | | | | | | | |
| Mining Journal<br>Weekly | 8 | 7 | 8 | 23 | G | 2 | 520 |
| Society of Mining Engineers, Transactions (AIME)<br>Monthly | 9 | 2 | 8 | 19 | G | 4 | 380 |
| Journal of Metals (AIME)<br>Monthly | 1 | 1 | 12 | 14 | G | 7 | 500 |
| Mining Congress Journal<br>Monthly | 4 | 7 | 2 | 13 | G | 8 | 250 |
| American Metal Market<br>Daily | 4 | 4 | 4 | 12 | G | 10 | 100 |
| Skillings Mining Review<br>Weekly | 2 | 3 | 1 | 6 | G | 18 | 280 |
| Metal Week<br>Weekly | 3 | 1 | 0 | 4 | G | 20 | 620 |
| 33-Magazine, Metal Producing<br>Monthly | 2 | 1 | 1 | 4 | G | 23 | 420 |
| Trans. Institute of Mining and Metallurgy, Section B<br>Monthly | 1 | 1 | 2 | 4 | G | 25 | 1002 |
| Canadian Mining and Metallurgical Bulletin<br>Monthly | 1 | 1 | 1 | 3 | G | 27 | 140 |
| Journal of The Air Pollution Control Association<br>Monthly | 1 | 1 | 1 | 3 | G | 28 | 200 |
| Canadian Mining Journal<br>Monthly | 0 | 1 | 1 | 2 | G | 34 | 130 |
| Canadian Metallurgical Quarterly<br>Quarterly | 1 | 1 | 0 | 2 | G | 35 | 120 |

(continued)

TABLE 5. (Continued)

| Document Title | No. Items Found In[(a)] A | B | C | Sum | Rate[(b)] | Rank[(c)] | ID Nos.[(d)] |
|---|---|---|---|---|---|---|---|
| Iron Age<br>Weekly | 1 | 0 | 1 | 2 | G | 36 | 180 |
| Trans. Institute of Mining and Metallurgy, Section C<br>Monthly | 1 | 0 | 0 | 1 | G | 45 | 1003 |
| Environmental Science and Technology<br>Monthly | 0 | 0 | 1 | 1 | G | 46 | 1000 |
| Trans Institute of Mining and Metallurgy, Section A<br>Monthly | 0 | 0 | 0 | 0 | G | 47 | 1001 |
| Journal of Hazardous Materials<br>Monthly | 1 | 0 | 0 | 1 | G | 48 | 1070 |
| Paydirt[(e)]<br>Weekly | | | | | G | 49 | 1080 |
| Hydrometallurgy<br>Quarterly | 4 | 10 | 4 | 18 | M | 50 | 1006 |
| Mining Magazine<br>Monthly | 3 | 5 | 3 | 11 | M | 51 | 270 |
| Metallurgical Transactions (ASM, AIME) Section B<br>Monthly | 3 | 6 | 0 | 9 | M | 52 | 320 |
| Engineering and Mining Journal<br>Monthly | 3 | 2 | 3 | 8 | M | 53 | 150 |
| Wall Street Journal<br>Daily | 2 | 0 | 2 | 4 | M | 56 | 390 |
| Mining Engineering<br>Monthly | 4 | 0 | 0 | 4 | M | 57 | 230 |
| Industry Week<br>Weekly | 1 | 1 | 1 | 3 | M | 61 | 160 |
| Business Week<br>Weekly | 1 | 1 | 0 | 2 | M | 65 | 110 |
| Barrons Business and Financial Weekly<br>Weekly | 0 | 0 | 2 | 2 | M | 67 | 410 |

(continued)

TABLE 5. (Continued)

| Document Title | No. Items[(a)] Found In A | B | C | Sum | Rate[(b)] | Rank[(c)] | ID[(d)] Nos. |
|---|---|---|---|---|---|---|---|
| Separation Science Quarterly | 0 | 0 | 0 | 0 | M | 96 | 290 |
| Filtration and Separation Bimonthly | 7 | 3 | 4 | 14 | X | 103 | 470 |
| **Foreign Periodicals** | | | | | | | |
| Izvestiya, VUZ, Tsvetnaya Metallurgiya (USSR) Bimonthly -- English TC[(f)] | 6 | 13 | 7 | 26 | G | 1 | 2 |
| Tsvetnyye Metally (USSR) Monthly -- In Russian | 12 | 10 | | 22 | G | 3 | 77 |
| Trudy Inst. Metallurgii I Obogashcheniia Acad. Nauk, Kazakh, SSR Bimonthly -- English TC | 8 | 6 | 4 | 18 | G | 5 | 78 |
| Rudodobiv (Bulgaria) Monthly -- English Abstracts | 6 | 6 | 3 | 15 | G | 6 | 67 |
| Erzmetall (Germany) Monthly -- English Abstracts | 6 | 4 | 3 | 13 | G | 9 | 18 |
| International Journal of Mineral Processing (Neth.) Monthly -- In English | 6 | 2 | 2 | 10 | G | 11 | 25 |
| Metall (Germany) Monthly -- English TC | 2 | 5 | 1 | 8 | G | 12 | 20 |
| Minerals Science and Engineering (South Africa) Monthly -- In English | 4 | 3 | | 7 | G | 13 | 33 |
| Neue Hutte (East Germany) Monthly -- English TC | 0 | 2 | 5 | 7 | G | 14 | 50 |
| Rudy I Metale Niezelazne (Poland) Monthly -- English Abstracts | 3 | 3 | 1 | 7 | G | 15 | 71 |
| World Mining (Australia) Monthly -- In English | 3 | 2 | 2 | 7 | G | 15 | 37 |

(continued)

TABLE 5. (Continued)

| Document Title | No. Items Found In[a] A | B | C | Sum | Rate[b] | Rank[c] | ID[d] Nos. |
|---|---|---|---|---|---|---|---|
| Australasian Institute of Mining And Metallurgical Proc. Monthly -- In English | 2 | 2 | 2 | 6 | G | 16 | 34 |
| Nat. Metallurgical Lab. Tech. Journal (India) Monthly -- In English | 0 | 6 | 0 | 6 | G | 17 | 40 |
| Bul. Res. Inst. Mineral Dressing and Met., Tohoku Univ. Monthly -- English TC | 2 | 0 | 3 | 5 | G | 19 | 85 |
| Australian Mining Monthly -- In English | 0 | 2 | 2 | 4 | G | 21 | 35 |
| Giesserei (Germany) Monthly -- English TC | 1 | 3 | 0 | 4 | G | 22 | 41 |
| Archiwum Hutnictwa/Pan (Poland) Quarterly -- English TC | 2 | 1 | 1 | 4 | G | 24 | 5 |
| Banyasyaii Es Kohazati Lapok-Kohaszat (Hungary) Monthly -- English Abstracts | 2 | 0 | 0 | 2 | G | 31 | 64 |
| Transactions Of The Indian Institute Of Metals Monthly -- In English | 0 | 2 | 0 | 2 | G | 32 | 82 |
| Indian Journal of Technology Monthly -- In English | 0 | 0 | 2 | 2 | G | 33 | 38 |
| Czechoslovak Heavy Industry Monthly -- In English | 0 | 1 | 1 | 2 | G | 38 | 3 |
| Hungarian Heavy Industry Quarterly -- In English | 0 | 1 | 1 | 2 | G | 39 | 4 |
| Trans. of The Nat. Research Inst. For Metals (Japan) Monthly -- In English | 1 | 0 | 0 | 1 | G | 40 | 91 |
| Hutnicke Listy (Czechoslovakia) Monthly -- English Abstracts | 0 | 1 | 0 | 1 | G | 42 | 61 |

(continued)

TABLE 5. (Continued)

| Document Title | No. Items Found In[(a)] A | B | C | Sum | (b) Rate | (c) Rank | ID Nos.[(d)] |
|---|---|---|---|---|---|---|---|
| Scandinavian Journal of Metallurgy (Sweden)<br>Monthly -- In English | 1 | 0 | 0 | 1 | G | 43 | 29 |
| Hitachi Review (Japan)<br>Monthly -- In English | 0 | 1 | 0 | 1 | G | 44 | 84 |
| Metallurgia ABM (Brazil)<br>Monthly -- In Portugese | 1 | 1 | 1 | 3 | M | 60 | 31 |
| Kinzoku (Japan)<br>Monthly -- In Japanese | 1 | 0 | 0 | 1 | M | 69 | 15 |
| Iron Age Metalworking International (Neth.)<br>Monthly -- In English | 0 | 0 | 0 | 0 | M | 88 | 26 |
| Revue Les Meoires Scientifiques De La Revue De Metallurgie<br>Monthly -- English Abstracts | 0 | 0 | 0 | 0 | M | 90 | 24 |

(a) The second, third, fourth, and fifth columns (A, B, C, and SUM, respectively) represent the numbers of pertinent information items found in the search of periodical issues.

(b) The sixth column (RATE) indicates an overall value of the document to the awareness task. G = Good, M = Moderate interest, X = Little or No interest.

(c) The seventh column (RANK) indicates priority order based on number of information items found per document. RANK is subordinate to RATE. All documents examined are included in the RANK order (i.e., Domestic and Foreign publications).

(d) The eighth column (ID NOS.) indicates an internal identification number.

(e) Issues not examined but document is known to be pertinent to the awareness task.

(f) TC is equal to Table of Contents.

## TABLE 6. PERIODICALS RECOMMENDED AS INFORMATION SOURCES FOR THE USEPA AWARENESS TASK

(Domestic and Foreign Publication Subgroups Listed in Alphabetical order)

| Document Title | No. Items Found In[a] |  |  |  | Rate[b] | Rank[c] | ID Nos.[d] |
|---|---|---|---|---|---|---|---|
|  | A | B | C | Sum |  |  |  |
| **United States, British, and Canadian Periodicals** |  |  |  |  |  |  |  |
| American Metal Market | 4 | 4 | 4 | 12 | G | 10 | 100 |
| Barrons Business and Financial Weekly | 0 | 0 | 2 | 2 | M | 67 | 410 |
| Business Week | 1 | 1 | 0 | 2 | M | 65 | 110 |
| Canadian Mining and Metallurgical Bulletin | 1 | 1 | 1 | 3 | G | 27 | 140 |
| Canadian Mining Journal | 0 | 1 | 1 | 2 | G | 34 | 130 |
| Canadian Metallurgical Quarterly | 1 | 1 | 0 | 2 | G | 35 | 120 |
| Engineering and Mining Journal | 3 | 2 | 3 | 8 | M | 53 | 150 |
| Environmental Science and Technology | 0 | 0 | 1 | 1 | G | 46 | 1000 |
| Filtration and Separation | 7 | 3 | 4 | 14 | X | 103 | 470 |
| Hydrometallurgy | 4 | 10 | 4 | 18 | M | 50 | 1006 |
| Industry Week | 1 | 1 | 1 | 3 | M | 61 | 160 |
| Iron Age | 1 | 0 | 1 | 2 | G | 36 | 180 |
| Journal of Hazardous Materials | 1 | 0 | 0 | 1 | G | 48 | 1070 |
| Journal of Metals (AIME) | 1 | 1 | 12 | 14 | G | 7 | 500 |
| Journal of The Air Pollution Control Association | 1 | 1 | 1 | 3 | G | 28 | 200 |
| Metallurgical Transactions (ASM, AIME) Section B | 3 | 6 | 0 | 9 | M | 52 | 320 |
| Metal Week | 3 | 1 | 0 | 4 | G | 20 | 620 |
| Mining Congress Journal | 4 | 7 | 2 | 13 | G | 8 | 250 |
| Mining Engineering | 4 | 0 | 0 | 4 | M | 57 | 230 |
| Mining Journal | 8 | 7 | 8 | 23 | G | 2 | 520 |
| Mining Magazine | 3 | 5 | 3 | 11 | M | 51 | 270 |

(continued)

TABLE 6. (Continued)

| Document Title | No. Items[a] Found In A | B | C | Sum | Rate[b] | Rank[c] | ID[d] Nos. |
|---|---|---|---|---|---|---|---|
| Paydirt[e] | | | | | G | 49 | 1080 |
| Separation Science | 0 | 0 | 0 | 0 | M | 96 | 290 |
| Skillings Mining Review | 2 | 3 | 1 | 6 | G | 18 | 280 |
| Society of Mining Engineers, Transactions (AIME) | 9 | 2 | 8 | 19 | G | 4 | 380 |
| 33-Magazine, Metal Producing | 2 | 1 | 1 | 4 | G | 23 | 420 |
| Trans. Institute of Mining and Metallurgy, Section A | 0 | 0 | 0 | 0 | G | 47 | 1001 |
| Trans. Institute of Mining and Metallurgy, Section B | 1 | 1 | 2 | 4 | G | 25 | 1002 |
| Trans. Institute of Mining and Metallurgy, Section C | 1 | 0 | 0 | 1 | G | 45 | 1003 |
| Wall Street Journal | 2 | 0 | 2 | 4 | M | 56 | 390 |
| **Foreign Periodicals** | | | | | | | |
| Archiwum Hutnictwa/Pan (Poland) | 2 | 1 | 1 | 4 | G | 24 | 5 |
| Australasian Institute of Mining and Metallurgical Proc. | 2 | 2 | 2 | 6 | G | 16 | 34 |
| Australian Mining | 0 | 2 | 2 | 4 | G | 21 | 35 |
| Banyasyaii Es Kohazati Lapok-Kohaszat (Hungary) | 2 | 0 | 0 | 2 | G | 31 | 64 |
| Bul. Res. Inst. Mineral Dressing and Met., Tohoku Univ. | 2 | 0 | 3 | 5 | G | 19 | 85 |
| Czechoslovak Heavy Industry | 0 | 1 | 1 | 2 | G | 38 | 3 |
| Erzmetall (Germany) | 6 | 4 | 3 | 13 | G | 9 | 18 |
| Giesserei (Germany) | 1 | 3 | 0 | 4 | G | 22 | 41 |
| Hitachi Review (Japan) | 0 | 1 | 0 | 1 | G | 44 | 84 |
| Hungarian Heavy Industry | 0 | 1 | 1 | 2 | G | 39 | 4 |
| Hutnicke Listy (Czechoslovakia) | 0 | 1 | 0 | 1 | G | 42 | 61 |
| Indian Journal of Technology | 0 | 0 | 2 | 2 | G | 33 | 38 |

(continued)

## TABLE 6. (Continued)

| | No. Items Found In[a] | | | | | | |
|---|---|---|---|---|---|---|---|
| Document Title | A | B | C | Sum | Rate[b] | Rank[c] | ID[d] Nos. |
| International Journal of Mineral Processing (Neth.) | 6 | 2 | 2 | 10 | G | 11 | 25 |
| Iron Age Metalworking International (Neth.) | 0 | 0 | 0 | 0 | M | 88 | 26 |
| Izvestiya, VUZ, Tsvetnaya Metallurgiya (USSR) | 6 | 13 | 7 | 26 | G | 1 | 2 |
| Kinzoku (Japan) | 1 | 0 | 0 | 1 | M | 69 | 15 |
| Metall (Germany) | 2 | 5 | 1 | 8 | G | 12 | 20 |
| Metallurgia ABM (Brazil) | 1 | 1 | 1 | 3 | M | 60 | 31 |
| Minerals Science and Engineering (South Africa) | 4 | 3 | | 7 | G | 13 | 33 |
| Nat. Metallurgical Lab. Tech. Journal (India) | 0 | 6 | 0 | 6 | G | 17 | 40 |
| Neue Hutte (East Germany) | 0 | 2 | 5 | 7 | G | 14 | 50 |
| Revue Les Meoires Scientifiques De La Revue De Metallurgie | 0 | 0 | 0 | 0 | M | 90 | 24 |
| Rudodobiv (Bulgaria) | 6 | 6 | 3 | 15 | G | 6 | 67 |
| Rudy I Metale Niezelazne (Poland) | 3 | 3 | 1 | 7 | G | 15 | 71 |
| Scandinavian Journal of Metallurgy (Sweden) | 1 | 0 | 0 | 1 | G | 43 | 29 |
| Transactions Of The Indian Institute of Metals | 0 | 2 | 0 | 2 | G | 32 | 82 |
| Trudy Inst. Metallurgii I Obogashcheniia Acad. Nauk, Kazakh, SSR | 8 | 6 | 4 | 18 | G | 5 | 78 |
| Trans. of The Nat. Research Inst. For Metals (Japan) | 1 | 0 | 0 | 1 | G | 40 | 91 |
| Tsvetnyye Metally (USSR) | 12 | 10 | | 22 | G | 3 | 77 |
| World Mining (Australia) | 3 | 2 | 2 | 7 | G | 15 | 37 |

(a), (b), (c), (d), and (e) same as in Table 5.

nonferrous metals and most of the processing operations of interest are reported in these periodicals. On the other hand, the group listed represents merely the recommended starting point. It is expected that this list will be modified as the need becomes apparent during the actual task operations.

Most of the documents in the recommended list can be searched for pertinent information by perusal of the tables of contents. A few documents will require page-by-page searching. Most of the foreign-language documents have tables of contents or abstracts of articles in English as an integral part of the publication, and no translation service would be required for initial searching. Only three foreign journals (one Russian, one Japanese, and one Brazilian) are exceptions, and translations of tables of contents would be required.

The stated desire by EPA to keep the considered task at a modest size would limit full translations of foreign-language articles to only those few selections that are most directly pertinent to the task. The amount of translation to be done would depend upon budgeting agreement between EPA and the task contractor.

The mechanics of inputting information from periodicals are straightforward. The documents listed are available in the various Battelle libraries or information centers and are readily accessed. The information analyst should perform the search on documents periodically and on a timely basis, record or copy (usually Xerox copies of entire articles) the pertinent information identified, including references, and return the document to the source. Translations of the most pertinent foreign language items should be obtained as required as previously mentioned. Transitory storage of copies of the information items as described in an earlier section of the report is recommended.

In addition to periodicals, it is recommended that abstract and other information services should become a part of the input element. As discussed previously, published abstracts typically lag the original publication by 3 to 6 months. Because of this lag, the various abstract publications and services are not of prime importance in the recommended input option. In addition, these services do not necessarily cover news tidbits which are frequently given in "department" sections of trade journals or magazines. However, the information covered by abstract services is broad and gives good coverage of the technical literature.

Accordingly, the periodic use of abstracts as a source of information to check the completeness of coverage of the primary literature search is recommended. Specifically, it is recommended that a search be made every 6 months that would return items indexed in the most recent 6-month period, and that two abstract sources (Engineering Index Monthly and Chemical Abstracts) be searched. These both are available as computer data bases (COMPENDEX and CHEMCON, respectively), and a search strategy should be devised so that the desired information could be retrieved at an effort currently estimated at about 2 to 3 technical man-hours per source accessed.

The printout returned from the searches would be compared against the articles culled via the primary periodicals search. This would allow assessment of primary coverage, and also might suggest periodic updating or modification of the primary reference list.

Specific and limited abstract publications are also available and should be reviewed. These include

- Copper Abstracts
- Lead Abstracts
- Selenium and Tellurium Abstracts
- Zinc Abstracts.

These are small, booklet-type publications with input independently culled from the larger abstract sources. These can be visually scanned for pertinent items in just a few minutes per booklet. It is recommended that these sources be reviewed as they are received by the library.

Another specific abstracting service that should be considered is the recent World Aluminum Abstract Data Base, entitled "Aluminum Industry and Environment". This new computerized source was brought to the attention of Battelle by EPA and is not yet available as a Battelle library service. As a consequence, we have not examined its content and potential utility, and can only generally recommend its "consideration".

In addition to the above, a number of information sources stemming from government-funded research and development are available. These include the following:

- Defense/Aerospace Contract Quarterly
- Commerce Business Daily - Contract Awards
- NASA RTOP
- DDC Work Unit Summaries (ERDA)
- Smithsonian Scientific Information Exchange (SSIE)
- TRIS (Department of Transportation)
- ERDA - Holifield Computer File (on-going programs)
- COMAT (an inventory initiated in FY 76 of total government materials R&D).

For the most part, data from these sources would not be germane. However, at least one of these sources, SSIE, should be assessed annually.

The Committee on Materials (COMAT) was chartered in 1975 by the Federal Council for Science and Technology. The establishment of the COMAT inventory of current R&D in materials from geological exploration through the use and discard or recycling of spent materials is but one of the COMAT functions. An inventory of current government-funded materials R&D has been established. An effort to inventory current R&D conducted by industry is expected in the near future. Presuming that the COMAT inventory is to be maintained on an annual basis, the annual access of this source would be a valuable input in the maintenance of awareness of nonferrous metals technology and could be available at a very moderate cost

Annual searching of the SSIE and COMAT facilities is recommended. The results would at least identify what research is in progress, and would afford contacts for further information (report requests and personal contact).

The total annual effort that would be required to meet the recommended actions relative to abstract and current R&D information is estimated to be on the order of 50 technical man-hours per year.

The comprehensive searching of each weekly issue of the *Official Gazette* (U.S. Patents) is not recommended as an activity of the awareness task. However, since it is believed that an awareness of the patent information would be useful, it is recommended that a patent search service should be subscribed to. It is understood that, with sufficiently narrowed search terms, such a service can be obtained at modest cost (estimated $100-200 annually). Details regarding patent search services are not available, but could be made available should the recommendation for the inclusion of patent coverage for the awareness task be accepted.

In addition to the formal published literature, it is recommended that company annual reports should be searched for information. Suggested companies whose reports would be of interest are given in Section 6. While company annual reports would be searched only once per year, this is a recommended source of information.

To augment the information available through the above literature and abstracting sources, attendance at, and participation in, selected relevant meetings, conferences, or symposia are recommended. This recommended activity would be useful in the following ways:

(1) It would provide direct input of some recently completed and on-going programs that might not appear in the periodicals for some months.

(2) It would provide direct input of some information that does not appear in published literature.

(3) It would allow the analyst to broaden his perspective in selected areas of interest by attending discussions which often add significantly to the formal material presented.

(4) It would provide the opportunity to meet and discuss topics with industrial, academic, and government representatives.

(5) When papers can be presented based on task activities, this should be done to assist in continuing rapport with other attendees.

(6) It hopefully would allow the analyst to establish contacts with key industry personnel. This could have long-range benefits to the task effort by providing a basis for continuing personal contacts.

Within the constraint imposed by the modest rate of effort desired by EPA for the considered task, only one or two major meetings would be allowed each year. The obvious meetings of first importance would be the Annual Meeting of the American Institute of Mining, Metallurgical, and Petroleum Engineers, typically held in February, and the Annual Conference of Metallurgists of the Canadian Institute of Mining and Metallurgy, customarily meeting in August.

Many journals contain calendars of events relevant to their topic areas. It is recommended that selected periodicals, such as the Journal of Metals, C.I.M. Bulletin, and Mining Magazine be scanned for upcoming meeting announcements. Abstract issues of metallurgically oriented periodicals would be perused to select meetings for attendance. Where seminars or meetings of potential special interest are announced for which programs are not normally printed in the periodical literature, program details would be solicited for review.

In addition to the above recommendations relating to formal technical meetings and their proceedings, annual visits to selected organizations are recommended. The principal organization recommended for at least exploratory contact are as follows:

- The Aluminum Association (NYC)
- Copper Institute (NYC)
- Lead Industries Association (NYC)
- Zinc Institute (NYC)
- U.S. Copper Association (NYC)
- Refractory and Reactive Metals Association (NYC)
- American Mining Congress (Washington)
- Lead-Zinc Producers Committee (Washington)
- U.S. Department of Commerce, Materials Division (Washington)
- U.S. Department of the Interior, Bureau of Mines (Headquarters, Washington)

From past contacts, staff in most of these industrial associations and government agencies are themselves charged with maintaining awareness of various segments and operations of the nonferrous metals industry. This expertise should be made available to the considered task on awareness of primary and secondary nonferrous metals technology.

As noted in this listing, the organizations that are considered most pertinent are located in Washington and the metropolitan New York areas. It is specifically recommended that a trip be planned to visit as many representatives of the above-listed organizations as is practical, based on exploratory phone discussions and within funding constraints.

Relative to this area of input (meetings and visitations) recommendations are as follows:

(1) Up to two extended annual meetings, symposia, or seminar series should be attended annually.

(2) In lieu of attendance at other meetings of pertinence, proceedings would be ordered and/or individual authors contacted for papers for review and analysis. These would be identified by perusal of calendars of events appearing in selected periodicals.

(3) A trip should be scheduled to visit selected trade associations and government agencies.

(4) The results of these activities would be analyzed for appropriate input to the awareness bulletins. In addition, brief trip summary reports should be prepared that might contain impressions or innuendos that would not be appropriate to a technical awareness bulletin, but still would have value to EPA.

The rate of effort estimated to be required for these activities is on the order of 200 technical man-hours, allowing about 50 man-hours for the review and analysis of pertinent purchased proceedings and/or collected papers. (There is scant basis for estimating the volume of such proceedings, but it is felt that this effort would be relatively modest.) An additional $1,500 would be required for expenses (travel, subsistence, meeting fees, literature purchase, telephone, etc.) associated with this recommended activity.

## INFORMATION ANALYSIS

The analysis function of any information system depends upon a combination of factors, including the experience and background of the analyst, the output form desired, and interaction of analyst and output user in the evolution of the most appropriate taxonomy and stragegy regarding meaningful output. These factors are considered for the awareness task analysis function.

A key factor in meaningful information analysis is the experience and background of the analyst. It is recommended that the awareness information system be staffed with a metallurgically oriented analyst who is also experienced in environmental aspects. Further, an analyst having familiarity with the operation of information systems would be desirable.

A newsletter-type output is recommended as the primary end product of the information operation. Topics for such an Awareness Bulletin might draw upon one or upon several related information inputs on a given subject for review-and-analysis reporting. The analyst would extract from available sources sufficient information to describe briefly the particular nonferrous metal industry activity and also to assess the potential of this activity for impact on the environment. It is recommended that the treatment of topics in the Awareness Bulletin be as definitive as possible, in spite of necessary brevity, and that presentation style and slant should conform to specific EPA objectives and needs.

The above cannot be accomplished without considerable interaction between the analyst and output user. While objectives and guidelines can be stated prior to and during start-up of an information system, proof testing of the adequacy of the output can best occur after experiencing a period of operation. Thus, communications from user to analyst regarding the output adequacy is recommended on a continuing basis. Such interaction should allow for a continuing evolution of the output to permit responsiveness to user needs. Strategies for information searching and treatment can thus be developed progressively to serve the requirements.

The output option of topical reports is suggested to supplement the awareness bulletin form of output should the need for in-depth studies in selected areas become apparent. The topical report output form is suggested as an add-on to the basic tasks of the information system. However, it is recommended that the analyst involved in producing the Awareness Bulletin should have key participation in the generation of any topical in-depth report that may prove to be a desired byproduct stemming from the information system activities. It is anticipated that the analyst would have firm knowledge of the bulk of the information sources required for the preparation of a topical report, as well as a preestablished familiarity with report user requirements. Based on the experience of Battelle-Columbus, the analyst would likely require the assistance of other specialists for specific inputs to a topical report, but nevertheless should occupy a key position in coordinating various inputs and in generating an overall analysis of the topical report.

## INFORMATION OUTPUT

### The Newsletter Format

It is recommended that a bimonthly newsletter output called an "Awareness Bulletin" should be the primary product of the information operation. The Awareness Bulletin should contain brief technology descriptions and assessments of environmental implications of pertinent technological development. The descriptions and analyses would be based on the information contained in one or more information items revealed in the searching operation plus any appropriate references from the prior literature and other background information that the analyst might have. Such sketches of the information items meriting attention would serve to alert the user of the Awareness Bulletin to existing or new nonferrous metals technology with specific emphasis on environmental implications.

The recommendation for bimonthly publication is based in part upon the crude results of the sample search conducted in this task, and in part upon the modest level of rate of effort desired by EPA for the considered task. Monthly reports would be preferable in maximizing the timely return of analyses to EPA, but are considered to be beyond the limits of the desired budget. Perhaps quarterly publication would be fiscally more compatible, but is considered as a probable serious compromise of the desired timeliness of reporting and analysis. The middle ground, bimonthly bulletins, appears to be optimum, and this initial plan is recommended.

The recommended format of the Awareness Bulletin is a series of information item presentations and analyses separated one from another in loose-leaf arrangement. Each presentation should begin on a separate page. Presentations might range from a half page to a few pages. It is anticipated that they should not be more than three pages including any data tables or figures to augment technology descriptions. The manuscript would be typed on appropriately formatted pages (suggested sample shown in Figure 1). For the limited number of copies presumed to be desired, office machine reproduction (i.e., Xerox, IBM) would be efficient.

The above recommended loose-leaf arrangement also is amenable to the information item filing system recommended. The filing system envisioned is based on a preliminary taxonomy of three classes -- metal, process, and environmental impact -- each with a number of appropriate categories. The system recommended is typified by the sample classification given in Table 7. Each information item presented in the Awareness Bulletin should be identified in a prominent place (e.g., adjacent to heading) with the appropriate filing code number per Table 7. Information items should be separated after the first perusal of the Awareness Bulletin (or some other appropriate time interval) for filing in the Awareness Bulletin file (loose-leaf notebook) under the appropriate classification and category. The producer of the Awareness Bulletin should follow the same scheme as the user in filing the information contained in issued bulletins.

The notebook file should be fitted with section separator pages (with labels) for the categories of the primary classification -- metals (i.e., section for copper, section for lead and zinc, etc. per Table 7). Within these major sections of the file, the information items should be arranged according to the additional classification schemes of processing operation and environmental impact per Table 7. It is recognized that the filing rank and order recommended here is arbitrary and that it could be modified to best reflect user requirements. However, the system is flexible enough to accommodate several different filing schemes, and should be implemented to permit the most convenient retrieval of information items from prior Awareness Bulletin issues.

In addition to the filing scheme described, it is recommended that each Awareness Bulletin issue contain a master reference page (references for individual item presentations also should appear at the end of each item presented). The master reference page would be an index for each Awareness Bulletin issue, consisting of headings of the information items

USEPA - AWARENESS BULLETIN Catalogue ____________

(Nonferrous Metals Technology) Page ____________

SUBJECT: ______________________________________

Figure 1. A Possible Awareness Bulletin Format

TABLE 7. SAMPLE CLASSIFICATION AND INDEXING SYSTEM RECOMMENDED FOR USE IN REPORTING AND FILING INFORMATION ITEMS PRESENTED IN AWARENESS BULLETINS[a]

| Primary Classification | | Secondary Classification | | Tertiary Classification | |
|---|---|---|---|---|---|
| Metals | Index No. | Process[b] | Index No. | Environmental Impact | Index No. |
| Copper (+As, Se, Te) | 01. | Mining (P) | .1 | Air (Human) | .1 |
| Lead and Zinc (+Sb, Cd, Tl) | 02. | Beneficiation (P) | .2 | Air (Ecology) | .2 |
| Aluminum (+Ga) | 03. | Smelting/Extraction (P) | .3 | Water (Human) | .3 |
| Titanium (+Zr, Hf) | 04. | Refining (P+S) | .4 | Water (Ecology) | .4 |
| Molybdenum (+Sn) | 05. | Ingot Melting (P+S) | .5 | Land (Human) | .5 |
| Rare Earths (+Y) | 06. | Presmelting (S) | .6 | Land (Ecology) | .6 |
| Beryllium (Be) | 07. | Smelting/Extraction (S) | .7 | Noise | .7 |
| Mercury (Hg) | 08. | Recycling Unspecified (S) | .8 | Multiple | .8 |
| Precious Metals (Au, Ag, Pt) | 09. | Multiple (P+S) | .9 | Not Determined | .9 |
| Tungsten (W) | 10. | | | | |
| Vanadium (V) | 11. | | | | |
| Columbium/Tantalum (Cb, Ta) | 12. | | | | |
| Nickel (+Co, Mn) | 13. | | | | |
| Magnesium (Mg) | 14. | | | | |
| Multiple | 15. | | | | |
| Unspecified | 16. | | | | |

(a) A three-tier system based on primary, secondary, and tertiary classifications having multiple categories within classifications as shown. Example: Index No. 07.8.1 would indicate beryllium scrap recycling operations with human health environmental impact implications.

(b) P = primary operations; S = secondary operations presented, followed by the references used in preparing that item. Each entry on the master reference page should be identified with the appropriate filing code number. Further, pagination of each bulletin should include the issue number and year, as well as the specific page number. Markings, as above, would serve to identify items from bulletins, pertinent references, and their currency even after disassembly of bulletins.

Master reference pages should be subsequently filed in the loose-leaf file in the reference section -- suggested as the first or opening section of the file. This arrangement should allow for the rapid scanning of file contents and easy retrieval of or reference to write-ups of particular interest. The producer of the Awareness Bulletin should follow the same scheme as the user in filing the information items contained in issued bulletins. Since no other permanent file of the information items used in generating the Awareness Bulletin is recommended, this scheme is suggested as a minimum cost method of accomplishing the information storage function.

The sample classification scheme recommended in Table 7 represents a useful indexing and filing system. The most useful detailed system will undoubtedly evolve as the generation of an Awareness Bulletin progresses. An important initial step in planning for the publication of the bulletin will be the mutual agreement between the EPA Project Officer and the analyst concerning the details of the taxonomy. Insofar as possible, the system should be devised to allow updating without the necessity for revision of indexing terms of prior publications.

## The In-Depth Topical Report

It is recommended that Topical In-Depth Reports should be considered on an add-on basis as an appropriate adjunctive activity of the information system should the need for such reports develop. Since the specific needs, objectives, levels-of-effort, timeliness, etc. applicable to Topical Reports cannot be anticipated, the only firm recommendation pertaining to such details is that the information sources and analysts of the awareness task should be used for any pertinent in-depth study requirements that develop. Objectives, funding, and details for the preparation of Topical Reports should be negotiated at the time of need.

## Communications

No formal visitation or telephone communication schedules are recommended for the awareness task. However, it is recommended that frequent communications between analyst and project officer and other users of the information system should be established early in the life of the system. The interaction should serve to modify and adjust system elements, particularly output, to best serve the awareness function. As the system matures and the adjustment needs diminish, continued informal personal communications via letter or telephone, and about two formal meetings per year, are recommended to serve any further system modification function and the interactive inquiry-answering type service that may infrequently but necessarily be required. Inquiry answering for parties requesting output that were not a part of the USEPA community should be established on a fee per service basis.

## RATE OF EFFORT ESTIMATES

From the recommended methodology, the following discussion presents estimates of the operational rates of effort and rationales expressed in man-hours (per year) for the various functions of the information system.

### Input from Periodicals

#### Screening--

From the mix of daily, weekly, monthly, bimonthly, and quarterly periodicals comprising the preferred list, 258 issues of periodicals would be available for screening for each bimonthly Awareness Bulletin issue. The breakdown of periodicals from the preferred list in terms of where published, publication frequency, and number of issues to be screened per Awareness Bulletin, is given in Table 8. The rate-of-effort requirements for screening these issues are as follows.

A screening time of about 5 minutes per issue is estimated to suffice for the screening of about half of the English language periodicals (issues) where no "department" or page-by-page screening is necessary. About the same length of screening time per issue is estimated to suffice for screening the tables of contents and the recording of titles of apparent interest for the foreign language periodicals. (Only three of the foreign language periodicals in the recommended listing do not have English tables of contents or English abstracts.) Issues of periodicals in the above category would require about 60 man-hours per year for screening.

The balance of periodical issues recommended for screening per Awareness Bulletin (about 115 issues) is estimated to require on the order of 15 minutes screening time per issue. These 115 issues per reporting period would therefore require about 170 man-hours per year for screening.

In addition to the screening times cited above, it is estimated that 20 man-hours per year would be required for translation of tables of contents of the three foreign language periodicals identified. Thus, the total screening operation is estimated to require 250 man-hours per year, largely accomplished by junior technical staff.

#### Copying Service--

Articles or news items of pertinence identified by the screening operation would be copied. A flat charge for copying is typically $0.07 per page. On the basis of the trial search, the roughly 258 issues of periodicals to be screened per reporting period may yield on the order of 200 to 300 items ranging from brief news items to full-length technical articles per bulletin issue. With an assumption that the average number of pages

TABLE 8. SUMMARY OF NUMBER OF PERIODICAL ISSUES RECOMMENDED TO BE SCREENED FOR EACH BIMONTHLY AWARENESS BULLETIN

| Publication Frequency | Issues Printed in English | | Issues Printed in Foreign Language but with English Table of Contents or Abstracts | | Issues Printed in Foreign Language | |
|---|---|---|---|---|---|---|
| | No. of Type to be Screened | Issues Screened per Bulletin(a) | No. of Type to be Screened | Issues Screened per Bulletin(a) | No. of Type to be Screened | Issues Screened per Bulletin(a) |
| U.S., British, and Canadian Publications | | | | | | |
| Daily | 2 | 88 | — | — | — | — |
| Weekly | 8 | 72 | — | — | — | — |
| Monthly(b) | 20 | 40 | — | — | — | — |
| Bimonthly | 1 | 1 | — | — | — | — |
| Quarterly | 3 | 2 | — | — | — | — |
| Total | 30 | 203 | — | — | — | — |
| Foreign Publications | | | | | | |
| Monthly | 13 | 26 | 10 | 20 | 3 | 6 |
| Bimonthly | 0 | 0 | 2 | 2 | 0 | 0 |
| Quarterly | 1 | 2/3 | 1 | 2/3 | 3 | 6 |
| Total | 14 | 26-2/3 | 13 | 22-2/3 | 3 | 6 |
| Grand Total | 44 | 229-2/3 | 57 | 252-1/3 | 60 | 258-1/3 |

(a) Considering 22 issues per month per daily periodical and 4.5 issues per month per weekly periodical.

(b) Includes four monthly metal abstract bulletins (copper, lead, zinc, and Se/Te) not listed with preferred periodicals.

per information item would be about four, the total copying cost is roughly estimated at $500/year. The reproduced copy would be delivered to the analyst for selection, review, and analysis.

Translation--

In addition to the nominal requirement for table-of-contents translations for screening purposes, a few carefully selected articles from foreign language journals are anticipated to be sufficiently important to warrant translation for detailed analysis. Without actual trial, there is no basis for estimating the number, size, or languages for these, all of which would influence the costs of translation. However, in keeping with the desire to maintain a modest program, it is suggested that $2,000 be appropriated initially for foreign article translations. Based on rough guidelines from Battelle-Columbus' Foreign Science Library's translation staff, this might allow for as few as 2 to 4 or as many as 8 to 10 full or partial translations.

Selection for Review and Analysis--

The analyst, upon receipt of articles and translations, would scan the information and select those writings that are truly pertinent, and perform initial subject cataloguing in line with the agreed-upon taxonomy. This selection process would reduce the volume of literature to a reasonable size for a bimonthly bulletin. This would best be done on a daily, or at least weekly basis, and would require an estimated 3 hours per week, or an annual effort on the order of 155 man-hours.

## Other Inputs

Library Abstract Services--

Semi-annual access of two abstract services, and annual access of research in progress and report literature have been recommended. The estimated annual cost of these searches, plus the recommended patent search to be performed as library or literature research services, is $600. In addition to the access charges, an estimated 50 hours of an analysts time per year would be required for analysis (comparison of the search results with periodical screening results) and ordering of documents to augment the input from periodical literature as required.

Meetings and Visits--

The recommended attendance at meetings (two major technical conferences per year) and visits to pertinent trade associations and selected government agencies (a concentrated one-week trip) would require an estimated 200 man-hours for the direct duties and the reporting and analysis of significant findings. In addition, travel and subsistence funds in support of these activities might amount to roughly $1,500.

## Review and Analysis

In the preparation of the recommended bimonthly Awareness Bulletin, the analyst would individually review, analyze, and prepare a brief written commentary for each selected item for each catalogue subject included.

This review and analysis operation would be expected to further cull the information to the truly significant items. As previously described, each catalogue subject would be prepared as an independent "mini-report" for inclusion in the Awareness Bulletin to facilitate filing by the user.

Based on similar review and analysis activities (e.g., "Reviews" prepared for MCIC at Battelle), we estimate that 90 to 100 hours of analyst time would be required for the review/analysis/manuscript preparation for each of the bimonthly Awareness Bulletin issues that are recommended. The total annual estimate is accordingly 570 man-hours for this function.

## Awareness Bulletin Publication and Distribution

The text, tables, figures and references of the Awareness Bulletin would be prepared according to the format previously described or with modifications as desired. The limited number of copies (e.g., 5 or 6 maximum) would be reproduced and distributed. The precise typing, drafting, editing and reproduction costs would, of course, vary with the number of pages per issue. This is unknown without trial, but as a rough estimate, it is assumed that 10 pages would be a reasonable length for a typical Awareness Bulletin. With this presumption, the preparation, reproduction, and distribution of each bulletin is estimated to require 20 hours for office staff and 10 hours for technical staff. Annual requirements would thus be 120 hours and 60 hours, respectively. Charges for materials, supplies, and direct equipment use are estimated at $200 per year for this function.

## Supportive Activities

In addition to the direct operations cited above, costs would be associated with supportive activities deemed essential to the performance of this task. These include:

- Telephone and letter communications and visits with the EPA Project Officer
- Telephone and letter communications in connection with obtaining information, pre-prints, reprints, and visits to industry associations and government agencies
- Required task coordination and administration expenses not directly related to specific Awareness Bulletin activities.

The costs for such supportive activities are estimated at 10 percent of the costs directly accruing to the obtaining, culling, review and analysis, and publication-associated costs for the Awareness Bulletin operations.

## Summary of Estimated Rate of Effort

Table 9 summarizes the estimated effort, and translates this into total estimated costs for the categorized labor grades and overheads currently

## TABLE 9. ESTIMATED ANNUAL RATE OF EFFORT IN MAN-HOURS AND OTHER COSTS BY ACTIVITY FOR THE AWARENESS BULLETIN TASK

| Activity | Estimated Annual Man-hours | | | Other Costs |
|---|---|---|---|---|
| | Sr. Technical[a] | Jr. Technical[b] | Nontechnical[c] | |
| Screening | — | 250 | — | — |
| Copying | — | — | — | $ 500 |
| Translation | — | — | — | 2,000 |
| Selection | 155 | — | — | — |
| Abstracts | 50 | — | — | 600 |
| Meetings & Visits | 200 | — | — | 1,500 |
| Review & Analysis | 570 | — | — | — |
| Bulletin Production | 60 | — | 120 | 200 |
| Subtotals | 1,035 | 250 | 120 | $4,800 |
| (Dollar Equivalents) | ($39,340) | ($6,250) | ($1,550) | ($4,800) |
| Supportive Activities (At ~10 Percent of Above) | ($3,934) | ($625) | ($155) | ($480) |
| Overall Estimated Cost is $57,140 | | | | |

(a) Assume fully burdened cost of $38/Hr.

(b) Assume fully burdened cost of $25/Hr.

(c) Assume fully burdened cost of $13/Hr.

exant at Battelle-Columbus. The largest element of cost accrues to the recommendation for use of a senior technical staff member with expertise as previously described.

The costs associated with the indicated levels of effort are, of course, somewhat flexible according to specific salary rates for the individuals that might be assigned. The level of effort (required man hours) is based on the preferred option recommendations resulting from discussions with the EPA Task Officer. Certainly other options or modifications may be considered at either modestly greater or lesser levels of effort. For example, limiting meeting attendance to one major technical meeting per year, and visitation to 4 instead of 10 to 12 organizations would result in roughly $4,000 less expenditure. Placing stringent limitations on retrievals from literature searching could reduce appreciably the selection effort required, and to some extent the review and analysis and bulletin preparation requirements. Such options would, of course, diminish the scope and/or depth of analysis that would otherwise be possible.

# APPENDIX A

## ALPHABETICAL LISTING OF ALL DOMESTIC AND FOREIGN PERIODICALS EXAMINED FOR PERTINENCY TO THE AWARENESS TASK

The listing is given in Table A-1. The first column, Document Title, establishes the alphabetical order of listing for all documents examined, both domestic and foreign publications. The second, third, fourth, and fifth columns represent the numbers of pertinent information items found during the source sampling exercise in periodical issues A, B, and C, and totals (labeled SUM). Blanks in these columns indicate issues not examined either because they were not available or because the document was judged to be inappropriate to the task (rated X in the adjacent sixth column).

The sixth column, labeled RATE, has entries indicating the overall value of the document to the awareness task. The G rating, for Good, was assigned to the most appropriate documents. M ratings were assigned to documents of moderate interest and X ratings were given documents having little or no pertinence to the considered task.

The seventh column, labeled RANK, has entries based on the number of pertinent information items found per document indicating highest priority (the lowest rank number) for documents having the highest number of information items. However, the rank number is subordinate to the rating. That is, a document wherein only four items were found during the sampling of three issues and rated G, was ranked higher than a document wherein ten items were found but was rated M, etc.

Whereas the rating and ranking of periodicals is disordered when the listing is in alphabetical order as in Table A-1, rated and ranked (ordered) presentations of documents are given in Sections 6 and 7.

The eighth column, labeled ID NOS., merely represents a document identification number for internal purposes.

## TABLE A-1. ALPHABETICAL LISTING OF DOMESTIC AND FOREIGN PERIODICALS EXAMINED FOR PERTINENCY TO THE AWARENESS TASK

| | No. Items Found In[a] | | | | | | |
|---|---|---|---|---|---|---|---|
| Document Title | A | B | C | Sum | Rate[b] | Rank[c] | ID[d] Nos. |
| Acta Metallurgica | 0 | 0 | 0 | 0 | X | 130 | 740 |
| Air Conditioning, Heating and Refrigeration | 0 | | | 0 | X | 131 | 750 |
| American Machinist | | | | | X | 158 | 760 |
| American Metal Market | 4 | 4 | 4 | 12 | G | 10 | 100 |
| Assembly Engineering | | | | | X | 159 | 770 |
| Australasian Corrosion Engineering | 0 | 1 | 2 | 3 | G | 26 | 36 |
| Australasian Institute of Mining And Metallurgical Proc. | 2 | 2 | 2 | 6 | G | 16 | 34 |
| Australian Mining | 0 | 2 | 2 | 4 | G | 21 | 35 |
| Archiwum Hutnictwa/Pan (Poland) | 2 | 1 | 1 | 4 | G | 24 | 5 |
| Automatic Machining | | | | | X | 160 | 780 |
| Banyasyaii Es Kohazati Lapok-Banyaszat (Hungary) | 1 | 0 | 0 | 1 | M | 80 | 63 |
| Banyasyaii Es Kohazati Lapok-Kohaszat (Hungary) | 2 | 0 | 0 | 2 | G | 31 | 64 |
| Banyasyaii Es Kohazati Lapok-Ontode (Hungary) | 1 | 0 | 0 | 1 | G | 41 | 65 |
| Barrons Business and Financial Weekly | 0 | 0 | 2 | 2 | M | 67 | 410 |
| Bell Labs Record | | | | | X | 189 | 790 |
| Bul. Res. Inst. Mineral Dressing and Met., Tohoku Univ. | 2 | 0 | 3 | 5 | G | 19 | 85 |
| Business Week | 1 | 1 | 0 | 2 | M | 65 | 110 |
| Canadian Journal of Chemistry | | | | | X | 188 | 800 |
| Canadian Journal of Physics | | | | | X | 187 | 810 |
| Canadian Metallurgical Quarterly | 1 | 1 | 0 | 2 | G | 35 | 120 |
| Canadian Mining and Metallurgical Bulletin | 1 | 1 | 1 | 3 | G | 27 | 140 |

(continued)

TABLE A-1. (Continued)

| Document Title | No. Items[a] Found In A | B | C | Sum | Rate[a] | Rank[b] | ID[d] Nos. |
|---|---|---|---|---|---|---|---|
| Canadian Mining Journal | 0 | 1 | 1 | 2 | G | 34 | 130 |
| Canadian Research and Development | 0 | 0 | 0 | 0 | X | 127 | 710 |
| Chemical and Engineering News | 1 | 0 | 1 | 2 | M | 64 | 440 |
| Chemical Week | 0 | 0 | 0 | 0 | X | 110 | 430 |
| Comptes Rendus Hebdomadaires Des Seances L. Acad. Sciences, B | 0 | 0 | 0 | 0 | M | 92 | 56 |
| Compes Rendus Hebodomadaires Des Seances L. Acad. Sciences, D | 0 | 0 | 0 | 0 | M | 123 | 55 |
| Control Engineering | | | | | X | 186 | 820 |
| Corrosion | | | | | X | 185 | 830 |
| Corrosion Science | | | | | X | 184 | 840 |
| Critical Reviews in Environmental Control | 0 | | | 0 | X | 118 | 580 |
| Czechoslovak Heavy Industry | 0 | 1 | 1 | 2 | G | 38 | 3 |
| Design Engineering | 0 | 0 | 0 | 0 | X | 128 | 720 |
| DFVLR Nachrichten (Germany) | | | | | X | 154 | 47 |
| Doklady Akademii Nauk (USSR) | 1 | 0 | 1 | 2 | G | 30 | 79 |
| Electrowarme-International (Germany) | 0 | 0 | 0 | 0 | X | 136 | 17 |
| Engineer | 0 | 0 | 0 | 0 | X | 111 | 450 |
| Engineering | 0 | 0 | 0 | 0 | X | 119 | 590 |
| Engineering and Mining Journal | 3 | 2 | 3 | 8 | M | 53 | 150 |
| Engineering Materials and Design | 0 | 0 | 0 | 0 | X | 120 | 600 |
| Environmental Science and Technology | 0 | 0 | 1 | 1 | G | 46 | 1000 |
| Erzmetall (Germany) | 6 | 4 | 3 | 13 | G | 9 | 18 |
| Filtration and Separation | 7 | 3 | 4 | 14 | X | 103 | 470 |
| Fitzika Metalov I. Metallovedeniye (USSR) | 0 | 0 | 0 | 0 | X | 115 | 1 |
| Fonderia (Italy) | 1 | 0 | 0 | 1 | M | 74 | 21 |

(continued)

TABLE A-1. (Continued)

| Document Title | No. Items[(a)] Found In A | B | C | Sum | Rate[(b)] | Rank[(c)] | ID[(d)] Nos. |
|---|---|---|---|---|---|---|---|
| Foundry Management and Technology | 1 | 2 | 1 | 4 | X | 107 | 460 |
| Foundry Trade Journal | 1 | 1 | 1 | 3 | M | 62 | 480 |
| Giesserei (Germany) | 1 | 3 | 0 | 4 | G | 22 | 41 |
| Giesserei Forschung (Germany) | 0 | 0 | 0 | 0 | X | 140 | 42 |
| Gieszereitechnik (Germany) | 1 | 0 | 1 | 2 | M | 63 | 19 |
| Hansa (Germany) | | | | | X | 152 | 49 |
| Heating, Piping and Air Conditioning | | | | | X | 183 | 850 |
| Hitachi Review (Japan) | 0 | 1 | 0 | 1 | G | 44 | 84 |
| Hungarian Heavy Industry | 0 | 1 | 1 | 2 | G | 39 | 4 |
| Hutnik (Czechoslovakia) | 1 | 0 | 0 | 1 | M | 81 | 62 |
| Hutnik (Poland) | 0 | 0 | 0 | 0 | M | 85 | 6 |
| Hutnicke Listy (Czechoslovakia) | 0 | 1 | 0 | 1 | G | 42 | 61 |
| Hydrometallurgy | 4 | 10 | 4 | 18 | M | 50 | 1006 |
| IEEE Transactions on Power Apparatus and Systems | | | | | X | 182 | 860 |
| IHI Engineering Review (Japan) | 0 | 0 | 1 | 1 | M | 71 | 12 |
| Ilmailu (Finland) | | | | | X | 151 | 51 |
| Indian And Eastern Engineer | 2 | 2 | 0 | 4 | M | 58 | 81 |
| Indian Journal of Technology | 0 | 0 | 2 | 2 | G | 33 | 38 |
| Industrial Water Engineering | 4 | 5 | 4 | 13 | X | 104 | 510 |
| Industriell Teknik (Sweden) | 0 | 0 | 0 | 0 | X | 144 | 52 |
| Industry Week | 1 | 1 | 1 | 3 | M | 61 | 160 |
| Inorganic Chemistry | | | | | X | 181 | 870 |
| International Journal of Mineral Processing (Neth.) | 6 | 2 | 2 | 10 | G | 11 | 25 |
| International Metallurgical Reviews | 0 | 0 | 0 | 0 | X | 124 | 680 |
| Inzynieria Chemiczna (Poland) | 1 | 0 | 0 | 1 | M | 72 | 7 |
| Iron Age | 1 | 0 | 1 | 2 | G | 36 | 180 |

(continued)

TABLE A-1. (Continued)

| Document Title | No. Items Found In[(a)] A | B | C | Sum | Rate[(b)] | Rank[(c)] | ID[(d)] Nos. |
|---|---|---|---|---|---|---|---|
| Iron Age Metalworking International (Neth.) | 0 | 0 | 0 | 0 | M | 88 | 26 |
| Izvestiya Acad. Nauk USSR, Metally | 3 | 1 |  | 4 | M | 59 | 73 |
| Izvestiya, VUZ, Tsvetnaya Metallurgiya (USSR) | 6 | 13 | 7 | 26 | G | 1 | 2 |
| Jernkontorets Annaler (Sweden) | 0 | 0 | 0 | 0 | X | 138 | 28 |
| Journal of Applied Mechanics (ASME Transactions) |  |  |  |  | X | 180 | 880 |
| Journal of Applied Physics |  |  |  |  | X | 179 | 890 |
| Journal of Hazardous Materials | 1 | 0 | 0 | 1 | G | 48 | 1070 |
| Journal of Heat Transfer (ASME Transactions |  |  |  |  | X | 178 | 900 |
| Journal of Metals (AIME) | 1 | 1 | 12 | 14 | G | 7 | 500 |
| Journal of Pressure Vessel Technology (ASME Trans.) |  |  |  |  | X | 177 | 910 |
| Journal of Scientific and Industrial Research (India) | 0 | 0 | 0 | 0 | M | 89 | 39 |
| Journal of The Air Pollution Control Association | 1 | 1 | 1 | 3 | G | 28 | 200 |
| Journal of The American Water Works Association | 0 | 0 | 1 | 1 | M | 75 | 190 |
| Journal Faculty of Eng., Tokyo Univ., Series A | 0 | 0 | 0 | 0 | M | 94 | 93 |
| Journal Faculity of Eng., Tokyo Univ., Series B | 0 | 0 | 0 | 0 | M | 97 | 94 |
| Journal Of The Japan Institute Of Metals | 0 | 0 | 0 | 0 | M | 87 | 14 |
| Journal Of The Water Pollution Control Federation | 1 | 2 | 1 | 4 | M | 55 | 210 |
| Kinzoku (Japan) | 1 | 0 | 0 | 1 | M | 69 | 15 |
| Kjemi (Sweden) | 0 | 0 | 0 | 0 | X | 145 | 54 |
| Kokubo (Japan) |  |  |  |  | X | 156 | 86 |

(continued)

TABLE A-1. (Continued)

| Document Title | No. Items[(a)] Found In A | B | C | Sum | (a) Rate | (b) Rank | ID[(d)] Nos. |
|---|---|---|---|---|---|---|---|
| La Fonderia Belge (Belgium) | 0 | 0 | 0 | 0 | X | 113 | 27 |
| La Metallurgia Italiana (Italy) | 0 | 0 | 0 | 0 | M | 86 | 22 |
| Machine Design | | | | | X | 176 | 920 |
| Materials Engineering | | | | | X | 175 | 930 |
| Materials Evaluation | | | | | X | 174 | 940 |
| Materials Science and Engineering | | | | | X | 173 | 950 |
| Materialno-Tekhnichesko Snaboyavane (Bulgaria) | 0 | 0 | 0 | 0 | X | 132 | 66 |
| MBB-Aktuell (Germany) | | | | | X | 153 | 48 |
| Mechanical Engineering | | | | | X | 172 | 960 |
| Metal Construction | 0 | 0 | 0 | 0 | X | 121 | 640 |
| Metal Science | 0 | 0 | 0 | 0 | X | 122 | 650 |
| Metal Week | 3 | 1 | 0 | 4 | G | 20 | 620 |
| Metall (Germany) | 2 | 5 | 1 | 8 | G | 12 | 20 |
| Metallovedeniya I Termicheskaya Obrabotka Metallov (USSR) | 0 | 0 | | 0 | X | 190 | 74 |
| Metallurg (USSR) | 0 | 0 | | 0 | X | 133 | 75 |
| Metallurgia ABM (Brazil) | 1 | 1 | 1 | 3 | M | 60 | 31 |
| Metallurgical Transactions (ASM, AIME) Section A | 0 | 0 | 0 | 0 | X | 112 | 330 |
| Metallurgical Transactions (ASM, AIME) Section B | 3 | 6 | 0 | 9 | M | 52 | 320 |
| Metallurgicheskaya I Gornorudnaya Promyshlennost (USSR) | 0 | 0 | | 0 | M | 105 | 76 |
| Metals and Materials | 4 | 0 | 0 | 4 | X | 108 | 560 |
| Metals Technology | 0 | 0 | 0 | 0 | M | 99 | 660 |
| Metalurgia (Rumania) | 1 | 0 | 1 | 2 | G | 37 | 10 |
| Metalurgija (Yugoslavia) | | | | | | | 80 |
| Mineral Research Bulletin | 0 | 0 | 0 | 0 | M | 84 | 490 |

(continued)

TABLE A-1. (Continued)

| Document Title | No. Items Found In[a] | | | | Rate[b] | Rank[c] | ID[d] Nos. |
|---|---|---|---|---|---|---|---|
| | A | B | C | Sum | | | |
| Minerals Science and Engineering (South Africa) | 4 | 3 | | 7 | G | 13 | 33 |
| Mine and Quarry | 1 | 4 | 4 | 9 | X | 106 | 260 |
| Mining Congress Journal | 4 | 7 | 2 | 13 | G | 8 | 250 |
| Mining Engineering | 4 | 0 | 0 | 4 | M | 57 | 230 |
| Mining Journal | 8 | 7 | 8 | 23 | G | 2 | 520 |
| Mining Magazine | 3 | 5 | 3 | 11 | M | 51 | 270 |
| Modern Castings | 1 | 0 | 0 | 1 | M | 83 | 630 |
| Modern Metals | 0 | 0 | 1 | 1 | M | 76 | 310 |
| Modern Power and Engineering | 0 | 0 | 0 | 0 | X | 129 | 730 |
| Nat. Metallurgical Lab. Tech. Journal (India) | 0 | 6 | 0 | 6 | G | 17 | 40 |
| National Technical Report (Japan) | 0 | 0 | 0 | 0 | X | 116 | 13 |
| Neue Hutte (East Germany) | 0 | 2 | 5 | 7 | G | 14 | 50 |
| NKG Transactions Of The Japan Institute of Metals | 0 | 0 | 0 | 0 | M | 91 | 83 |
| Ocean Engineering | | | | | X | 171 | 970 |
| Ochrona Powietrza (Poland) | 3 | | | 3 | G | 29 | 8 |
| Paydirt | | | | | G | 49 | 1080 |
| Polymer Engineering and Science | | | | | X | 170 | 980 |
| Prace Instytutow Hutniczych (Poland) | 0 | 0 | 1 | 1 | M | 73 | 9 |
| Product Engineering | | | | | X | 169 | 990 |
| Problemy Projektowo Hutnictwa I Przemyslu Maszynowego (Poland) | 2 | 2 | 1 | 5 | M | 54 | 70 |
| Prometal (Switzerland) | 0 | 0 | 0 | 0 | X | 114 | 30 |
| Radex Rundschau (Germany) | 1 | 0 | 0 | 1 | M | 79 | 45 |
| Report Inst. of Industrial Science, Tokyo Univ. | 0 | 0 | | 0 | M | 102 | 95 |
| Research/Development | 0 | 0 | 1 | 1 | M | 78 | 300 |

(continued)

## TABLE A-1. (Continued)

| Document Title | No. Items[(a)] Found In | | | | | | |
|---|---|---|---|---|---|---|---|
| | A | B | C | Sum | [(a)] Rate | [(b)] Rank | ID[(d)] Nos. |
| Revista Latinoamericana De Siderurgia (Chile) | 0 | 0 | 0 | 0 | X | 139 | 32 |
| Revue De L Aluminum (France) | 0 | 0 | 0 | 0 | X | 146 | 57 |
| Revue De Metallurgie (France) | 0 | 0 | 0 | 0 | X | 137 | 23 |
| Revue Generale Des Techniques La Metal. Const. Mech. | 0 | 0 | 0 | 0 | X | 148 | 60 |
| Revue International Hautes Temp. Refracktaires | 0 | 0 | 0 | 0 | X | 147 | 58 |
| Revue Les Meoires Scientifiques De La Revue De Metallurgie | 0 | 0 | 0 | 0 | M | 90 | 24 |
| Rubber Chemistry and Technology | | | | | X | 168 | 1005 |
| Rubber World | | | | | X | 167 | 1010 |
| Rudodobiv (Bulgaria) | 6 | 6 | 3 | 15 | G | 6 | 67 |
| Rudy I Metale Niezelazne (Poland) | 3 | 3 | 1 | 7 | G | 15 | 71 |
| Scandinavian Journal of Metallurgy (Sweden) | 1 | 0 | 0 | 1 | G | 43 | 29 |
| Science of Sintering (Yugoslavia) | | | | | | | 11 |
| Science Reports Research Inst., Tohoku Univ., Series A | 0 | 0 | 0 | 0 | M | 100 | 92 |
| Sea Technology | | | | | X | 166 | 1020 |
| Separation Science | 0 | 0 | 0 | 0 | M | 96 | 290 |
| Shin Boei Ronshu (Japan) | | | | | X | 157 | 87 |
| Skillings Mining Review | 2 | 3 | 1 | 6 | G | 18 | 280 |
| Society of Mining Engineers, Transactions (AIME) | 9 | 2 | 8 | 19 | G | 4 | 380 |
| Spisanie Na Bulgarskoto Geologichesko Druzhestvo (Bulgaria) | 1 | 0 | 1 | 2 | M | 66 | 68 |
| Sprechsaal (Germany) | 0 | 0 | 0 | 0 | X | 143 | 46 |
| Sumitomo Metals (Japan) | 0 | 0 | | 0 | M | 95 | 89 |
| Tetsu-To-Hagane (Japan) | 0 | 0 | 0 | 0 | X | 135 | 16 |
| Teknikens Vorld (Sweden) | | | | | X | 150 | 53 |

(continued)

## TABLE A-1. (Continued)

| Document Title | No. Items[a] Found In | | | | Rate[b] | Rank[c] | ID[d] Nos. |
|---|---|---|---|---|---|---|---|
| | A | B | C | Sum | | | |
| The British Foundryman | 0 | 0 | 0 | 0 | X | 117 | 570 |
| The Mine Magazine | 1 | 0 | 0 | 1 | M | 68 | 1004 |
| The Sumitomo Search (Japan) | 0 | 0 | 0 | 0 | X | 134 | 90 |
| 33-Magazine, Metal Producing | 2 | 1 | 1 | 4 | G | 23 | 420 |
| Tooling and Production | | | | | X | 164 | 1040 |
| Trade Times, Japanese Machinery Exporters Assoc. Bull. | 0 | 0 | 0 | 0 | M | 101 | 88 |
| Transactions Of The Indian Institute of Metals | 0 | 2 | 0 | 2 | G | 32 | 82 |
| Trans. Institute of Mining and Metallurgy, Section A | 0 | 0 | 0 | 0 | G | 47 | 1001 |
| Trans. Institute of Mining and Metallurgy, Section B | 1 | 1 | 2 | 4 | G | 25 | 1002 |
| Trans. Institute of Mining and Metallurgy, Section C | 1 | 0 | 0 | 1 | G | 45 | 1003 |
| Trans. of The Nat. Research Inst. for Metals (Japan) | 1 | 0 | 0 | 1 | G | 40 | 91 |
| Trudy Inst. Metallurgii I Obogashcheniia Acad. Nauk. Kazakh, SSR | 8 | 6 | 4 | 18 | G | 5 | 78 |
| Tsvetnyye Metally (USSR) | 12 | 10 | | 22 | G | 3 | 77 |
| VDI Zeitschrift (Germany) | 0 | 0 | 0 | 0 | X | 141 | 43 |
| Verres Et Refractaires (France) | | | | | X | 149 | 59 |
| VGB Kraft Werkstechnik (Germany) | 0 | 0 | 0 | 0 | X | 142 | 44 |
| Wall Street Journal | 2 | 0 | 2 | 4 | M | 56 | 390 |
| Water Air and Soil Pollution | 1 | 0 | 0 | 1 | M | 70 | 1005 |
| Water and Pollution Control | 0 | 0 | 0 | 0 | X | 126 | 700 |
| Water and Wastes Engineering | 1 | 0 | 0 | 1 | M | 77 | 350 |
| Water Research | 2 | 2 | 0 | 4 | X | 109 | 360 |
| Welding Design and Fabrication | 0 | 0 | 0 | 0 | X | 125 | 690 |

(continued)

TABLE A-1. (Continued)

| Document Title | No. Items[(a)] Found In A | B | C | Sum | [(b)] Rate | [(c)] Rank | ID[(d)] Nos. |
|---|---|---|---|---|---|---|---|
| Welding Journal | | | | | X | 162 | 1060 |
| Wiadmosci Hutnicze (Poland) | 0 | 0 | 0 | 0 | M | 98 | 72 |
| World Mining (Australia) | 3 | 2 | 2 | 7 | G | 15 | 37 |
| Zashchita Na Prirodata (Bulgaria) | | | | | X | 155 | 69 |

(a) The second, third, fourth, and fifth columns (A, B, C, and SUM, respectively) represent the numbers of pertinent information items found in the search of periodical issues.

(b) The sixth column (RATE) indicates an overall value of the document to the awareness task. G = Good, M = Moderate interest, X = Little or No interest.

(c) The seventh column (RANK) indicates priority order based on number of information items found per document. RANK is subordinate to RATE. All documents examined are included in the RANK order (i.e., Domestic and Foreign publications).

(d) The eighth column (ID Nos.) indicates an internal identification number.

Note: There are no periodicals ranked 82, 93, 161, 163, or 165. There are two documents ranked 15.

# APPENDIX B

## COMAT RETRIEVAL DESCRIPTION

COMAT is a BASIC language computer data package prepared for the FCST - authorized Committee on Materials. It contains about 2,300 records describing federally-funded materials research and development programs. The file is maintained by Battelle-Columbus as part of the BASIS program.

COMAT was accessed as a demonstration for Task 54 and the printout is given in Table B-1. Three retrievals were made, as follows:

(1) Metal ores or nonferrous metals were combined with mine development, mining, primary metal winning processes, or waste management as processing operations. A total of 25 records were retrieved, and are shown in the following list under PRINT 9 (Page B-2).

(2) For the above records, an added specification to select programs dealing in part with a description of emission sources or emission reduction was keyed. This reduced the retrieval to two records. These are displayed under PRINT 11 in the following list (Page B-10).

(3) Only one of the 25 records described a project that is in force (or was planned for FY 76) that was started primarily because of a desire to influence the impact on the environment. This is displayed under PRINT 13 (Page B-11).

## TABLE B-1. RECORDS FROM THE COMAT DATA BASE

### PRINT 9

```
RECORD 1
ACCESSION NO     :  111
CONTRACTOR       :  FEDERAL GOVERNMENT
TITLE            :  BENEFICIATION OF NONMAGNETIC TACONITES
CONTRACT NO      :  9366/5170
SPONSOR          :  DOI
AGENCY           :  BU MINES
   LABORATORY    :  MET
FUNDING          :  700
STATUS           :  CONT
OBJECTIVE        :  PROC  :  DEV
MISSION          :  MATL  :  REDEV
MATERIAL         :  MTOR  :  MNRL  :  NORN  :  MTRS  :  MOM
FUNCTION         :  SR  :  PRM

RECORD 2
ACCESSION NO     :  114
CONTRACTOR       :  FEDERAL GOVERNMENT
TITLE            :  PROCESSING COPPER-NICKEL AND COPPER ORES
CONTRACT NO      :  9366/5166
SPONSOR          :  DOI
AGENCY           :  BU MINES
   LABORATORY    :  MET
FUNDING ($)      :  300
STATUS           :  CONT
OBJECTIVE        :  PROC  :  DEV
MISSION          :  MATL  :  REDEV
MATERIAL         :  MTOR  :  MNRL  :  NORN  :  MTRS  :  MOM  :  ADDE NICKEL
FUNCTION         :  PRM
KEY WORDS        :  COBALT  :  SILVER  :  DULUTH GABBRO  :  NICKEL  :  LOW-
                     GRADE RESOURCE  :  ENVIRONMENT

RECORD 3
ACCESSION NO     :  121
CONTRACTOR       :  FEDERAL GOVERNMENT
TITLE            :  ELECTRO DEPOSITION TECHNOLOGY
CONTRACT NO      :  9367/5148
SPONSOR          :  DOI
AGENCY           :  BU MINES
   LABORATORY    :  MET
FUNDING ($)      :  160
STATUS           :  CONT
OBJECTIVE        :  PREF  :  COST
MISSION          :  METL  :  MP  :  IND
MATERIAL         :  NFRS  :  METL  :  PRMAT  :  MOM
```

(continued)

## TABLE B-1. (Continued)

FUNCTION : REF : PRM
KEY WORDS : COPPER : CHANNEL CELL

RECORD 4
ACCESSION NO : 129
CONTRACTOR : FEDERAL GOVERNMENT
TITLE : NICKEL RECOVERY FROM WESTERN RESOURCES
CONTRACT NO : 9368/4580
SPONSOR : DOI
AGENCY : BU MINES
LABORATORY : MET
FUNDING ($) : 360
OBJECTIVE : PROC : DEV
MISSION : MATL : REDEV
MATERIAL : MTOR : MARL : NORN : MTRS : MOM
FUNCTION : SR : PRM
KEY WORDS : COBALT

RECORD 5
ACCESSION NO : 132
CONTRACTOR : FEDERAL GOVERNMENT
TITLE : RECOVERY OF IRON AND TITANIUM FROM TITANIFEROUS MAGNETITES
CONTRACT NO : 9368/4582
SPONSOR : DOI
AGENCY : BU MINES
LABORATORY : MET
FUNDING ($) : 300
STATUS : INIT
OBJECTIVE : PROC : DEV
MISSION : MATL : REDEV
MATERIAL : MTOR : MARL : NORN : MTRS : MOM
FUNCTION : CONV : PRM
KEY WORDS : LOW-GRADE RESOURCE : SMELTING : FLUORSPAR

RECORD 6
ACCESSION NO : 133
CONTRACTOR : FEDERAL GOVERNMENT
TITLE : RECOVERY OF CHROMIUM FROM DOMESTIC SOURCES
CONTRACT NO : 9368/4583
SPONSOR : DOI
AGENCY : BU MINES
LABORATORY : MET
FUNDING ($) : 130
OBJECTIVE : PROC : DEV
MISSION : MATL : REDEV
MATERIAL : MTOR : MNRL : NORN : MOM
FUNCTION : CONV : PRM
KEY WORDS : LOW-GRADE RESOURCE : CHROMITE : STILLWATER COMPLEX

(continued)

TABLE B-1. (Continued)

RECORD 7
ACCESSION NO : 134
CONTRACTOR : FEDERAL GOVERNMENT
TITLE : STEEL FROM PREREDUCED PELLETS
CONTRACT NO : 9368/4570
SPONSOR : DOI
AGENCY : BU MINES
LABORATORY : MET
FUNDING ($) : 70
STATUS : CONT
OBJECTIVE : PROC : DEV
MISSION : METL : MP : IND
MATERIAL : MTOR : MNRL : NORN : MTRS : MOM
FUNCTION : REF : PRM

RECORD 8
ACCESSION NO : 135
CONTRACTOR : FEDERAL GOVERNMENT
TITLE : CHLORINATION OF ILMENITE
CONTRACT NO : 9368/4574
SPONSOR : DOI
AGENCY : BU MINES
LABORATORY : MET
FUNDING ($) : 330
STATUS : CONT
OBJECTIVE : PROC : DEV
MISSION : MATL : REDEV
MATERIAL : MTOR : MNRL : NORN : MTRS : MOM
FUNCTION : CONV : PRM

RECORD 9
ACCESSION NO : 145
CONTRACTOR : FEDERAL GOVERNMENT
TITLE : PRODUCTION OF ALUMINA FROM DOMESTIC RESOURCES
CONTRACT NO : 9369/4057
SPONSOR : DOI
AGENCY : BU MINES
LABORATORY : MET
FUNDING ($) : 240
STATUS : CONT
OBJECTIVE : PROC : DEV
MISSION : MATL : REDEV
MATERIAL : MTOR : MNRL : NORN : MTRS : MOM
FUNCTION : SR : PRM
KEY WORDS : CLAY : LEACHING : ALUMINUM : LOW-GRADE RESOURCE

RECORD 10
ACCESSION NO : 147

(continued)

TABLE B-1. (Continued)

CONTRACTOR : FEDERAL GOVERNMENT
TITLE : RECOVERY OF SILVER FROM REFRACTORY OR LOW-GRADE RESOURCES
CONTRACT NO : 9369/4076
SPONSOR : DOI
AGENCY : BU MINES
LABORATORY : MET
FUNDING ($) : 360
STATUS : CONT
OBJECTIVE : PROC : DEV
MISSION : MATL : REDEV
MATERIAL : MTOR : MNRL : NORN : MTRS : MOM
FUNCTION : PRM
KEY WORDS : GOLD : ELECTRODEPOSITION

RECORD 11
ACCESSION NO : 148
CONTRACTOR : FEDERAL GOVERNMENT
TITLE : RECOVERY OF HEAVY MINERALS
CONTRACT NO : 9369/4075
SPONSOR : DOI
AGENCY : BU MINES
LABORATORY : MET
FUNDING ($) : 80
STATUS : INIT
OBJECTIVE : PROC : DEV
MISSION : MATL : REDEV
MATERIAL : MTOR : MNRL : NORN : MTRS : MOM
FUNCTION : RECVA : WAST
KEY WORDS : BLACK SANDS : TAILINGS : MAGNETITE : ILMENITE : CHROMITE

RECORD 12
ACCESSION NO : 149
CONTRACTOR : FEDERAL GOVERNMENT
TITLE : LOW-COST METALS FOR NUCLEAR POWER GENERATION
CONTRACT NO : 9369/4072
SPONSOR : DOI
AGENCY : BU MINES
LABORATORY : MET
FUNDING ($) : 200
STATUS : CONT
OBJECTIVE : PREF : COST
MISSION : FIS : NUCS : EPG : ENRG
MATERIAL : MTOR : MNRL NORN : MTRS : MOM
FUNCTION : SR : PRM
KEY WORDS : ZIRCONIUM : HAFNIUM : SEPARATION

(continued)

TABLE B-1. (Continued)

RECORD 13
ACCESSION NO : 150
CONTRACTOR : FEDERAL GOVERNMENT
TITLE : RECOVERY OF LEAD AND ZINC FROM SULFIDE CONCENTRATES BY CHLORINE LEACHING
CONTRACT NO : 9369/4071
SPONSOR : DOI
AGENCY : BU MINES
LABORATORY : MET
FUNDING ($) : 520
STATUS : CONT
OBJECTIVE : PROC : DEV
MISSION : METL : MP : IND
MATERIAL : MTOR : MNRL : NORN : MTRS : MOM
FUNCTION : PRM
KEY WORDS : PROC : REDN : EMIS : ELECTRO DEPOSITION : FUSED SALT

RECORD 14
ACCESSION NO : 153
CONTRACTOR : FEDERAL GOVERNMENT
TITLE : COPPER PROCESSING TECHNOLOGY
CONTRACT NO : 9370/4121
SPONSOR : DOI
AGENCY : BU MINES
LABORATORY : MET
FUNDING ($) : 175
STATUS : CONT
OBJECTIVE : PROC : DEV
MISSION : METL : MP : IND
MATERIAL : MTOR : MNRL : NORN : MTRS : MOM
FUNCTION : PRM
KEY WORDS : CHALCOPYRITE

RECORD 15
ACCESSION NO : 155
CONTRACTOR : FEDERAL GOVERNMENT
TITLE : GOLD AND SILVER MINERAL PROCESSING
CONTRACT NO : 9370/4127
SPONSOR : DOI
AGENCY : BU MINES
LABORATORY : MET
FUNDING ($) : 180
STATUS : CONT
OBJECTIVE : PROC : DEV
MISSION : MATL : REDEV
MATERIAL : MTOR : MNRL : NORN : MTRS : MOM
FUNCTION : SR : PRM
KEY WORDS : LOW-GRADE RESOURCE : REFRACTORY ORE : LEACHING

(continued)

TABLE B-1. (Continued)

RECORD 16
ACCESSION NO : 156
CONTRACTOR : FEDERAL GOVERNMENT
TITLE : RECOVERY OF TUNGSTEN FROM SEARLES LAKE BRINES
CONTRACT NO : 9370/4129
SPONSOR : DOI
AGENCY : BU MINES
LABORATORY : MET
FUNDING ($) : 100
STATUS : CONT
OBJECTIVE : PROC : DEV
MISSION : MATL : REDEV
MATERIAL : MTOR : MNRL : NORN : MTRS : MOM
FUNCTION : SR : PRM

RECORD 17
ACCESION NO : 157
CONTRACTOR : FEDERAL GOVERNMENT
TITLE : RECOVERY OF MANGANESE FROM OCEAN NODULES
CONTRACT NO : 9370/4141
SPONSOR : DOI
AGENCY : BU MINES
LABORATORY : MET
FUNDING ($) : 50
STATUS : CONT
OBJECTIVE : PROC : DEV
MISSION : MATL : REDEV
MATERIAL : MTOR : MNRL : NORN : MTRS : MOM
FUNCTION : CONV : PRM
KEY WORDS : SEA NODULES : NICKEL : COPPER : COBALT

RECORD 18
ACCESSION NO : 160
CONTRACTOR : FEDERAL GOVERNMENT
TITLE : IMPROVED COPPER LEACHING
CONTRACT NO : 9370/4123
SPONSOR : DOI
AGENCY : BU MINES
LABORATORY : MET
FUNDING ($) : 235
STATUS : CONT
OBJECTIVE : PROC : DEV
MISSION : METL : MP : IND
MATERIAL : MTOR : MNRL : NORN : MTRS : MOM
FUNCTION : PRM

RECORD 19
ACCESSION NO : 165
CONTRACTOR : FEDERAL GOVERNMENT

(continued)

TABLE B-1. (Continued)

```
TITLE             :  COBALT AND NICKEL RECOVERY FROM MISSOURI LEAD ORES
CONTRACT NO       :  9371/4156
SPONSOR           :  DOI
AGENCY            :  BU MINES
   LABORATORY     :  MET
FUNDING ($)       :  125
STATUS            :  CONT
OBJECTIVE         :  PROC  :  DEV
MISSION           :  SEMAT  :  MP  :  IND
MATERIAL          :  MTOR  :  MNRL  :  NORN  :  MTRS  :  MOM
FUNCTION          :  RECVA  :  WAST
KEY WORDS         :  CHALCOPYRITE  :  SIEGENITE  :  TAILINGS  :  BYPRODUCT

RECORD 20
ACCESSION NO      :  166
CONTRACTOR        :  FEDERAL GOVERNMENT
TITLE             :  BASE-METAL PROCESSING
CONTRACT NO       :  9371/4111
SPONSOR           :  DOI
AGENCY            :  BU MINES
   LABORATORY     :  MET
FUNDING ($)       :  300
STATUS            :  CONT
OBJECTIVE         :  PROC  :  DEV
MISSION           :  SEMAT  :  MP  :  IND
MATERIAL          :  MTOR  :  MNRL  :  NORN  :  MTRS  :  MOM
FUNCTION          :  PRM
KEY WORDS         :  LOW-GRADE RESOURCE  :  SPHALERITE  :  ZINC  :  COBALT  :
                      NICKEL  :  BYPRODUCT  :  ELECTRODEPOSITION

RECORD 21
ACCESSION NO      :  174
CONTRACTOR        :  FEDERAL GOVERNMENT
TITLE             :  MINIPLANT EVALUATION OF ALUMINA RECOVERY PROCESS
CONTRACT NO       :  9486/4191
SPONSOR           :  DOI
AGENCY            :  BU MINES
   LABORATORY     :  MET
FUNDING ($)       :  730
STATUS            :  CONT
OBJECTIVE         :  PPLT  :  EVAL
MISSION           :  MATL  :  REDEV
MATERIAL          :  MTOR  :  MNRL  :  NORN  :  MTRS  :  MOM
FUNCTION          :  SR  :  PRM
KEY WORDS         :  ALUMINUM  :  ALUNITE  :  ANORTHOSITE  :  COST EVALUATION :
                      LOW GRADE RESOURCE

RECORD  22
ACCESSION NO      :  646
```

(continued)

CONTRACTOR : OTHER
ENVMAT : METAL : PROCES
TITLE : PROCESS EVALUATION WASTE CHARACTERIZATION AND CONTROL SYSTEM DEVELOPMENT RELATIVE TO NONFERROUS METALS PROCESSING
SPONSOR : ENVIRONMENTAL PROTECTION AGENCY
FUNDING ($) : 1073
ENVFUN : PRODUC
ENVTYP : MULTI : EMIS
STATUS : CONT
OBJECTIVE : PROC : DEV
MISSION : ENVQ
MATERIAL : NFRS : METL : PRMAT : MOM : ADDE POL
FUNCTION : DISP : WAST
KEY WORDS : PROC : REDN : EMIS : POLLUTANTS : RESIDUALS : POINT SOURCE : INDUSTRIAL PROCESSES : COPPER

RECORD 23
ACCESSION NO : 1057
CONTRACTOR : PRIVATE
TITLE : DESIGN OF LARGE ALUMINA PILOT PLANTS
SPONSOR : DOI
AGENCY : BU MINES
LABORATORY : MET
FUNDING ($) : 2005
STATUS : 1/1
OBJECTIVE : MRSE : DEV
MISSION : MATL : REDEV
MATERIAL : MTOR : MNRL : NORN : MTRS : MOM
FUNCTION : SR : PRM
KEY WORDS : ALUMINUM : LOW-GRADE RESOURCE

RECORD 24
ACCESSION NO : 1060
CONTRACTOR : FEDERAL GOVERNMENT
TITLE : MATERIALS FOR CONSTRUCTION OF GEOTHERMAL ENERGY CONVERSION PLANTS
CONTRACT NO : 9448/5158
SPONSOR : DOI
AGENCY : BU MINES
LABORATORY : MET
FUNDING ($) : 165
STATUS : CONT
OBJECTIVE : MTTK : DEV
MISSION : MATL : REDEV
MATERIAL : MTOR : MNRL : NORN : MTRS : MOM
FUNCTION : SR : PRM
KEY WORDS : BRINE : LITHIUM: MANGANESE : MAGNESIUM : LEAD

(continued)

## TABLE B-1. (Continued)

```
RECORD 25
ACCESSION NO     :  1826
CONTRACTOR       :  OTHER
TITLE            :  ZIRCONIUM POWDER PRODUCTION STUDY
SPONSOR          :  DEPARTMENT OF DEFENSE
AGENCY           :  AIR FORCE
   LABORATORY    :  AIR FORCE MATERIALS LABORATORY
FUNDING ($)      :  184
STATUS           :  INIT
OBJECTIVE        :  TECH  :  EVAL
MISSION          :  MUNI  :  DEF
MATERIAL         :  NFRS  :  METL  :  PRMAT  :  MOM
FUNCTION         :  REF  :  PRM
KEY WORDS        :  THERMAL BATTERIES  :  MISSILES  :  MATERIAL SHORTAGE  :
                     CRITICAL MATERIAL  :  NEW MATERIAL SOURCE
```

PRINT 11

```
RECORD 1
ACCESSION NO     :  150
CONTRACTOR       :  FEDERAL GOVERNMENT
TITLE            :  RECOVERY OF LEAD AND ZINC FROM SULFIDE CONCENTRATES BY
                      CHLORINE LEACHING
CONTRACT NO      :  9369/4071
SPONSOR          :  DOI
AGENCY           :  BU MINES
   LABORATORY    :  MET
FUNDING ($)      :  520
STATUS           :  CONT
OBJECTIVE        :  PROC  :  DEV
MISSION          :  METL  :  MP  :  IND
MATERIAL         :  MTOR  :  MNRL  :  NORN  :  MTRS  :  MOM
FUNCTION         :  PRM
KEY WORDS        :  PROC  :  REDN  : EMIS  : ELECTRO DEPOSITION  : FUSED SALT


RECORD 2
ACCESSION NO     :  646
CONTRACTOR       :  OTHER
  ENVMAT         :  METAL  :  PROCES
TITLE            :  PROCESS EVALUATION WASTE CHARACTERIZATION AND CONTROL
                      SYSTEM DEVELOPMENT RELATIVE TO NONFERROUS METALS
                      PROCESSING
SPONSOR          :  ENVIRONMENTAL PROTECTION AGENCY
FUNDING ($)      :  1073
  ENVFUN         :  PRODUC
  ENVTYP         :  MULTI  :  EMIS
STATUS           :  CONT
```

(continued)

## TABLE B-1. (Continued)

```
OBJECTIVE       :  PROC  :  DEV
MISSION         :  ENVQ
MATERIAL        :  NFRS  :  METL  :  PRMAT  :  MOM  :  ADDE POL
FUNCTION        :  DISP  :  WAST
KEY WORDS       :  PROC  :  REDN  :  EMIS  :  POLLUTANTS  :  RESIDUALS  :
                     POINT SOURCE INDUSTRIAL PROCESSES  :  COPPER  :  LEAD  :
                     ZINC
```

## PRINT 13

```
RECORD 1
ACCESSION NO    :  646
CONTRACTOR      :  OTHER
  ENVMAT        :  METAL  :  PROCES
TITLE           :  PROCESS EVALUATION WASTE CHARACTERIZATION AND CONTROL
                     SYSTEM DEVELOPMENT RELATIVE TO NONFERROUS METALS
                     PROCESSING
SPONSOR         :  ENVIRONMENTAL PROTECTION AGENCY
FUNDING ($)     :  1073
  ENVFUN        :  PRODUC
  ENVTYP        :  MULTI  :  EMIS
STATUS          :  CONT
OBJECTIVE       :  PROC  :  DEV
MISSION         :  ENVQ
MATERIAL        :  NFRS  :  METL  :  PRMAT  :  MOM  :  ADDE POL
FUNCTION        :  DISP  :  WAST
KEY WORDS       :  PROC  :  REDN  :  EMIS  :  POLLUTANTS  :  RESIDUALS  :
                     POINT SOURCE INDUSTRIAL PROCESSES  :  COPPER  :  LEAD  :
                     ZINC
```

---

```
     THE ABOVE LISTING IS BASED ON THE FOLLOWING -

          ITEMS     LINE      REQUEST
     *      27       1/       MAT,MTOR
     *       5       2/       FUN,MDEV
     *      75       3/       FUN,MQ
     *     107       4/       FUN,PRM                COMAT ENCODING
     *     137       5/       FUN,WAST               SHEETS FOR THE
     *     324       6/       (2030405)              MNEMONICS USED
     *      87       7/       MAT,NFRS               IN THIS INVENTORY
     *     114       8/       (107)                  ARE SHOWN ON PAGES
     *      25       9/       (6A8)                  B-12 AND B-13.
     *     285      10/       KW,EMIS
     *       2      11/       (9A10)
     *     161      12/       MIS,ENVQ
     *       1      13/       (9A12)
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# COMAT ENCODING SHEET, SIDE 1

1) Accession Number ____________________

2) Contractor Name
☐ Federal Government ☐ State and Local Government ☐ Private ☐ Academic ☐ Not for Profit ☐ National Labs. ☐ Other

7) Contract Title ____________________

8) Contract Number ____________________

9) Sponsoring Directive ____________________

10) Specific Agency ____________________

11) Agency Laboratory, Division, etc. ____________________

18) Dollar Funding ____________________

19) Status of Contract ____________________

## 20) OBJECTIVE OF RESEARCH PROGRAM

- ☐ DEV Development or Upgrading of:
  - ☐ RSRC Resources
  - ☐ PROC Processes
  - ☐ MATL Materials and Material Application
  - ☐ ____________________
- ☐ EDUC Education
  - ☐ RSSP Research Support
  - ☐ NITH New Information and Theory
  - ☐ ____________________
- ☐ EVAL Evaluation of:
  - ☐ RSRC Resources
  - ☐ TECH Technical-Economic
  - ☐ PPLT Pilot Plant Operations
  - ☐ EMPO Emissions and Pollutants
  - ☐ ENCO Energy Utilization and Consumption
  - ☐ ____________________
- ☐ SUBS Substitution of Materials for:
  - ☐ FOSL Fossil Hydrocarbons
    - ☐ PETR Petroleum Products
    - ☐ NTGS Natural Gas
    - ☐ COKE Coke or High-Rank Coal
  - ☐ SCEX Strategic, Critical, or Expensive Materials
    - ☐ FLRS Fluorspar
    - ☐ PLAT Platinum
    - ☐ CHRO Chromium
    - ☐ NICK Nickel
    - ☐ CATY Catalysts
    - ☐ ____________________
  - ☐ ____________________
- ☐ COST Cost Reduction
  - ☐ PREF Improved Process Efficiency
  - ☐ MATY Improved Material Yield/Recovery
  - ☐ EQLF Improved Equipment Life
  - ☐ ____________________
- ☐ CNSV Conservation of Resources and Materials
- ☐ ENRC Conservation of Energy
- ☐ ENVT Environmental Protection
  - ☐ ____________________
- ☐ ADDS Additional Descriptor
  - ☐ ____________________
- ☐ MLTP Multiple
- ☐ UNSP Unspecified
- ☐ OTHR Other
  - ☐ ____________________

## 22) MISSION

- ☐ COMSEN Communication & Sensing
  - ☐ MMC Mass Media Communication
  - ☐ PC Private Communication
  - ☐ GIGL Group, Interagency, Governmental Communication
  - ☐ DET Detection
    - ☐ OBJ Objects
    - ☐ ENT Events

## 22) MISSION (Continued)

- ☐ TRANS Transportation
  - ☐ AIR Air
  - ☐ RAIL Rail
  - ☐ HWAY Highway
  - ☐ PLINE Pipeline
  - ☐ WATR Water
  - ☐ MHL Materials Handling and Logistics
  - ☐ PROSY Propulsion Systems
  - ☐ AREAL Areal (Urban, Interurban, Interstate, International)
  - ☐ ____________________
- ☐ SPACE Space
  - ☐ EXPLO Exploration (Mariner, Grand Tour, etc.)
  - ☐ EXPER Experimentation (Workshop, Spacelab, etc.)
  - ☐ WOSAT Working Satellites (ERTS, COMSAT, etc.)
  - ☐ STRAN Transportation (Shuttle, Tug, etc.)
  - ☐ HABEN General Habitat and Environment
  - ☐ MSDR Material and Systems Development Reliability
  - ☐ ____________________
- ☐ ENRG Energy
  - ☐ RSRC Resources
  - ☐ CNSV Conservation
  - ☐ UTICON Utilization and Consumption
  - ☐ CONV Conversion
  - ☐ STOR Storage
  - ☐ TRADI Transmission and Distribution
  - ☐ ETRAN Energy for Transportation
  - ☐ EPG Electrical Power Generation
    - ☐ FOPL Fossil Plants
    - ☐ SES Solar Energy Systems
    - ☐ GTHM Geothermal
    - ☐ HELEC Hydroelectric
    - ☐ WSYS Wind Systems
    - ☐ NUCS Nuclear Systems
      - ☐ FIS Fission
        - ☐ CONPL Conventional Plants
        - ☐ ADSYS Advanced Systems
        - ☐ BREA Breeder Reactors
      - ☐ FUS Fusion
  - ☐ ____________________
- ☐ ENVQ Environmental Quality
  - ☐ AGRI Agricultural Impacts
  - ☐ MBIM Mining and Beneficiation Impacts
  - ☐ INDIM Industrial Impacts
  - ☐ COMIM Commercial Impacts
  - ☐ DOMIM Domestic Impacts
  - ☐ GOVIM Government Impacts
  - ☐ INSIM Institutional Impacts
  - ☐ ____________________
- ☐ HLTH Health
  - ☐ BIOMA Biocompatible Materials
  - ☐ APDEV Appliances and Devices
  - ☐ ____________________
- ☐ SAFT Safety
  - ☐ SIND Industrial
  - ☐ SDOM Domestic
  - ☐ SPGD Protective Gear and Devices
  - ☐ ____________________
- ☐ CONST Construction
  - ☐ RDHY Roads and Highways
  - ☐ BRI Bridges
  - ☐ CONID Industrial
  - ☐ CONIM Commercial

## 22) MISSION (Continued)

- ☐ IND Industrial
  - ☐ MP Material Processing
    - ☐ METL Metals
    - ☐ CRMC Ceramics
    - ☐ SYNT Synthetics
    - ☐ COMP Composites
    - ☐ SEMAT Secondary Materials
    - ☐ ____________________
  - ☐ MANU Manufacturing
    - ☐ TEQP Tools and Equipment
    - ☐ CONG Consumer Goods
    - ☐ ____________________
  - ☐ ____________________
- ☐ REDEV Resource Development
  - ☐ MATL Materials
  - ☐ ENRG Energy Resources
  - ☐ NATR Natural Resources
  - ☐ ____________________
- ☐ CNSV Conservation
  - ☐ MATL Materials
  - ☐ ENRG Energy Resources
  - ☐ NATR Natural Resources
  - ☐ ____________________
- ☐ SEC Security
  - ☐ LENF Law Enforcement
  - ☐ DISC Disaster Control
  - ☐ ____________________
- ☐ ECON Economics
  - ☐ SDR Supply/Demand Relationships
  - ☐ CAC Cost Analysis and Criteria
  - ☐ INRE International Relationships
  - ☐ FIN Finance
  - ☐ ____________________
- ☐ EDT Education and Development of Knowledge
  - ☐ ____________________
- ☐ AGR Agriculture
  - ☐ FRST Forests
  - ☐ GFAR General Farming
    - ☐ CROP Crops
    - ☐ HUSB Husbandry
  - ☐ ____________________
- ☐ OENG Ocean Engineering
  - ☐ PS Physical Science
  - ☐ MS Mineral Science
  - ☐ BS Biological Science
  - ☐ ____________________
- ☐ DEF Defense
  - ☐ AC Aircraft
  - ☐ MIS Missiles
  - ☐ LVEH Land Vehicles
  - ☐ SHP Ships
  - ☐ WC Watercraft
  - ☐ DESPA Space
  - ☐ ARM Armament
  - ☐ MUNI Munitions
  - ☐ SUEQU Support Equipment
- ☐ MULT Multiple
- ☐ UNSP Unspecified
- ☐ ADDS Addition Descriptor

# COMAT ENCODING SHEET, SIDE 2

## 23) MATERIALS

- ☐ MUD Materials, Direct Use
  - ☐ ERTH Earth
    - ☐ ROCK Rock & Crushed Rock
    - ☐ STON Stone
    - ☐ GRVL Gravel
    - ☐ SAND Sand
    - ☐ CLAY Clay
  - ☐ WATR Water
  - ☐ AIR Air
  - ☐ ____________________
- ☐ MOM Materials of Manufacture
  - ☐ MTRS Material Resources
    - ☐ NORN Nonrenewable Resources
      - ☐ MNRL Mineral Resources
        - ☐ MTOR Metal Ores
        - ☐ NMOR Nonmetal Ores
      - ☐ CHEM Chemical Resources
        - ☐ INOR Inorganic
        - ☐ ORGN Organic
      - ☐ GAS Gases
    - ☐ RNBL Renewable Resources
      - ☐ FRST Forest Products
      - ☐ PLNT Plant Products, (Nonfood)
      - ☐ ANML Animal Material (Nonfood)
      - ☐ SCRP Scrap
      - ☐ WAST Waste and Refuse
      - ☐ ____________________
  - ☐ PRMAT Processed Materials
    - ☐ METL Metals and Alloys
      - ☐ FERS Ferrous (Including Ferroalloys)
      - ☐ NFRS Nonferrous
      - ☐ CMPD Compounds
      - ☐ ____________________
    - ☐ CRMC Ceramics (Including Carbides, Nitrides, etc.)
      - ☐ INCR Industrial Ceramics
      - ☐ CNCR Construction Ceramics
      - ☐ ELCR Electronic Ceramics
      - ☐ RFCR Refractory Ceramics
      - ☐ DMCR Domestic & Decorative Ceramics
      - ☐ CRMT Cermets
      - ☐ ____________________
    - ☐ FIBR Natural Fiber Materials
      - ☐ PAPR Paper Products
      - ☐ WOOD Wood Products
      - ☐ TXTL Textiles
      - ☐ ROPE Rope and Cord
      - ☐ ____________________
    - ☐ SYNT Synthesized Materials
      - ☐ PLST Plastics
      - ☐ CHMS Chemicals
      - ☐ INOR Inorganics
      - ☐ ____________________
    - ☐ COMP Composite Materials
      - ☐ ORCO Organic Composites
      - ☐ CRCO Ceramic Composites
      - ☐ MTCO Metallic Composites
      - ☐ OCCO Organo-Ceramic Composites
      - ☐ OMCO Organo-Metallic Composites
      - ☐ MCCO Metalo-Ceramic Composites
      - ☐ FBCO Fiber (Filamentary) Composites
      - ☐ ____________________
    - ☐ BYPR By-Products
    - ☐ SCRP Scrap
    - ☐ WAST Waste and Refuse
      - ☐ GWST Gaseous Waste
      - ☐ LWST Liquid Waste
      - ☐ SWST Solid Waste
      - ☐ WSTC Combination Wastes
      - ☐ IWST Industrial Waste
      - ☐ CWST Commercial Waste
      - ☐ AWST Agricultural Waste
      - ☐ DWST Domestic Waste
      - ☐ UREF Urban Refuse
      - ☐ NUCL Nuclear Waste
      - ☐ ____________________

## 23) MATERIALS (Continued)

- ☐ MBF Materials by Form (Not Otherwise Specified)
  - ☐ PNTS Paints and Lacquers
  - ☐ CTGS Other Coatings
  - ☐ MILL Mill Product Forms
    - ☐ FMET Metal Products
    - ☐ FCER Ceramic Forms
    - ☐ FTXT Textile Mill Products
    - ☐ FAGR Agricultural Product Forms
  - ☐ ____________________
- ☐ FUEL Fuel Materials
  - ☐ FOSL Fossil Hydrocarbons
    - ☐ COAL Coal, Peat, Lignite, Coke
    - ☐ PETR Petroleum Products
    - ☐ NTGS Natural Gas
    - ☐ SNGS Synthetic Gas
    - ☐ ____________________
  - ☐ FWOD Wood and Charcoal
  - ☐ FPAP Paper
  - ☐ WAST Waste and Refuse
  - ☐ NUCL Nuclear
  - ☐ ____________________
- ☐ MBP Materials by Function or Property (N.O.S.)
  - ☐ FERT Fertilizers
  - ☐ SPCN Superconductors
  - ☐ MGNT Magnetics
  - ☐ REFR Refractories
  - ☐ CORR Corrosion Resistant Materials
  - ☐ ABRA Abrasives
  - ☐ BIOL Biologicals
  - ☐ ENRG Energy Materials
  - ☐ ENVC Environmental Control Materials
  - ☐ TRBR Trade and Barter Materials
  - ☐ LUBR Lubricants
  - ☐ BLST Ballast Materials
  - ☐ PGMT Pigments
  - ☐ CNST Construction Materials
  - ☐ STRL Structural Materials
  - ☐ ____________________
- ☐ UNSP Unspecified Materials
- ☐ MLTP Multiple Material Classes
- ☐ ADDS Additional Descriptor
  - ☐ ____________________
- ☐ OTHR Other Materials
  - ☐ ____________________

## 24) FUNCTIONS (Stage in Material Cycle)

- ☐ EXRS Exploration for Resources
  - ☐ GEO Geological
  - ☐ MAR Marine
  - ☐ SPA Space
- ☐ PERM Preparation for Extraction of Raw Materials
  - ☐ MDEV Mine Development
  - ☐ II Innoculating, Incubating
  - ☐ PLCU Planting, Cultivating
  - ☐ DW Drilling, Well Conditioning
- ☐ ERM Extraction of Raw Materials
  - ☐ MQ Mining and Quarrying
  - ☐ HAR Harvesting
  - ☐ PUMP Pumping
- ☐ PRM Processing of Raw Materials
  - ☐ SR Separation and Recovery (Threshing, Beneficiation, etc.)
  - ☐ CONV Conversion (Roasting, Smelting, Crushing, Leaching, etc.)
  - ☐ REF Refining (Distilling, Electrorefining, BOF Processing, etc.)
- ☐ MFRM Manufacturing and Fabrication of Refined Materials
  - ☐ PRI Primary (Alloying, Casting, Spinning, Synthesis, etc.)
  - ☐ SEC Secondary (Rolling, Drawing, Extruding, Weaving, etc.)
  - ☐ FIN Finish (Straightening, Heat Treating, Polishing, Coating, etc.)

## 24) FUNCTIONS (Continued)

- ☐ APP Application and Utilization of Finished Materials
- ☐ EMP Evaluation of Material Properties (New Data Development)
  - ☐ PHY Physical
  - ☐ CHEM Chemical
  - ☐ MECH Mechanical
- ☐ DNIP Development of New or Improved Materials
- ☐ WAST Waste Management
  - ☐ RECVA Recovery of Values
  - ☐ RECY Recycling
  - ☐ DISP Disposal
  - ☐ ECRES Ecological Restoration
- ☐ ENRG Energy Consumption
- ☐ MULT Multiple
- ☐ UNSP Unspecified
- ☐ ADDE Additional Descriptors
  - ☐ ____________________
- ☐ OTHR Other
  - ☐ ____________________

## 25) KEY WORDS

- ☐ EMIS Emission
  - ☐ CHAR Characterization
  - ☐ REDN Reduction
    - ☐ PROC Process Change
    - ☐ CONT Effluent Control
    - ☐ SUBS Material Substitution

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